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JULY 1957

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SIXTY-SIXTH YEAR OF PUBLICATION

JULY 1957

THE American JOURNAL OF Surgery

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(1) Farmer, D. A.: M. Clin. North America *38*:1403, 1954. (2) Lichtman, S. S.: Diseases of the Liver, Gallbladder and Bile Ducts, ed. 3, Philadelphia, Lea & Febiger, 1953, vol. 2, pp. 1146, 1150, 1302. (3) Rosser, J. H., and McCall, R. A.: U. S. Armed Forces M. J. *5*:658, 1954. (4) Schwimmer, D.; Boyd, L. J., and Rubin, S. H.: Bull. New York M. Coll. *16*:102, 1953. (5) Best, R. R.; Rasmussen, J. A., and Wilson, C. E.: A.M.A. Arch. Surg. *67*:839, 1953. (6) Pearse, H. E.: Am. J. Surg. *89*:1191, 1955.

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1. Zintel, H. A.: *Surg. Clin. North America,* 36:257, Apr., 1956. 2. Freeman, B. S.; and Young, T. K., Jr.: *Arch. Surg.,* 61:1145, Dec., 1950.

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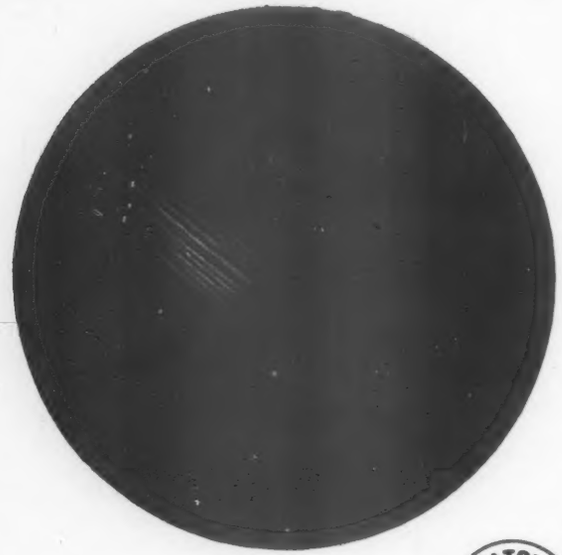

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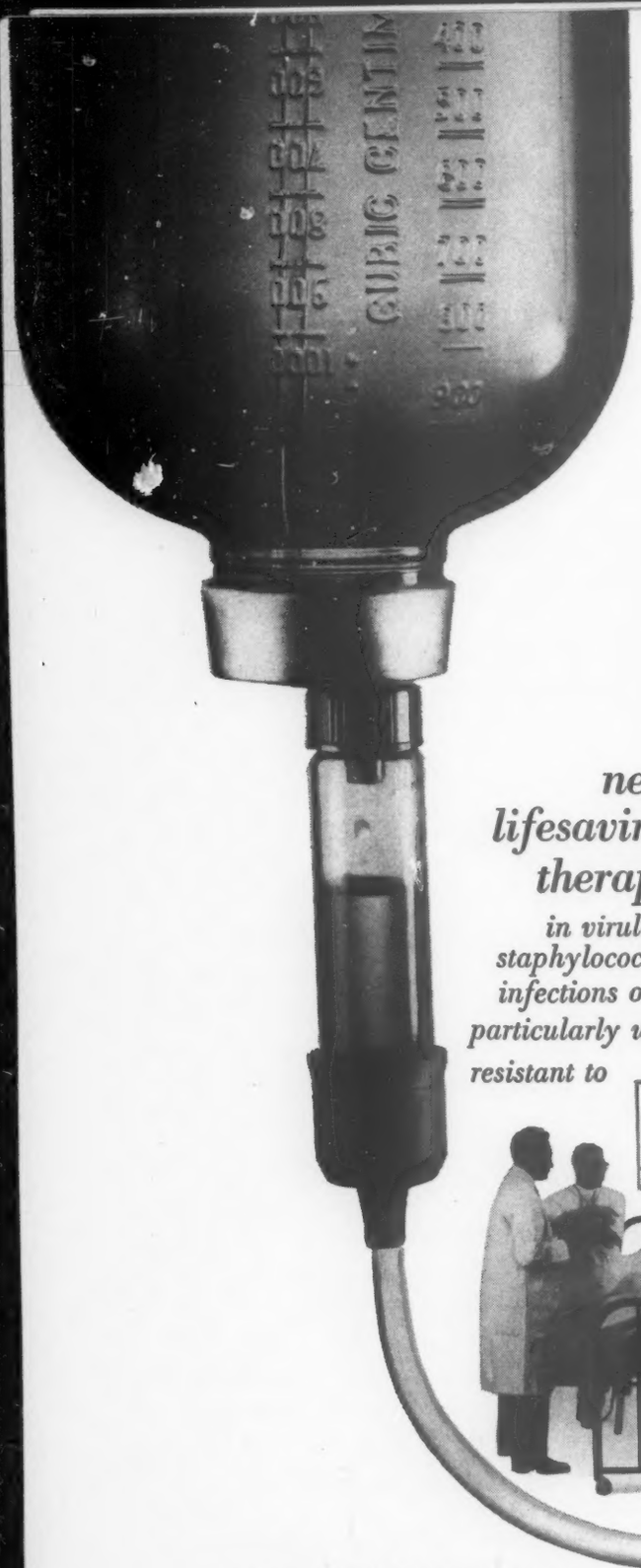

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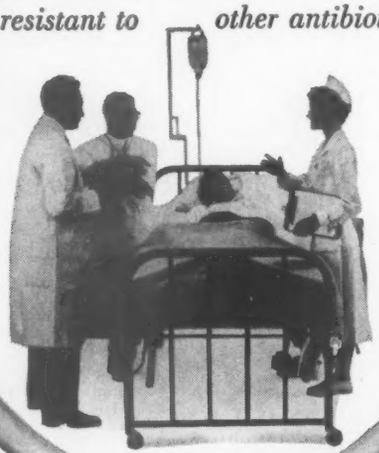

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THOMAS B. NOBLE

The patient, a female, had undergone operation for peritonitis, with partial and complete obstruction scattered along the small bowel around multiple abscessed areas. A year later her symptoms returned. At the second operation the terminal ileum was found to be invaginated into the cecum for 2 inches. Technic of operative procedure and the result are presented.

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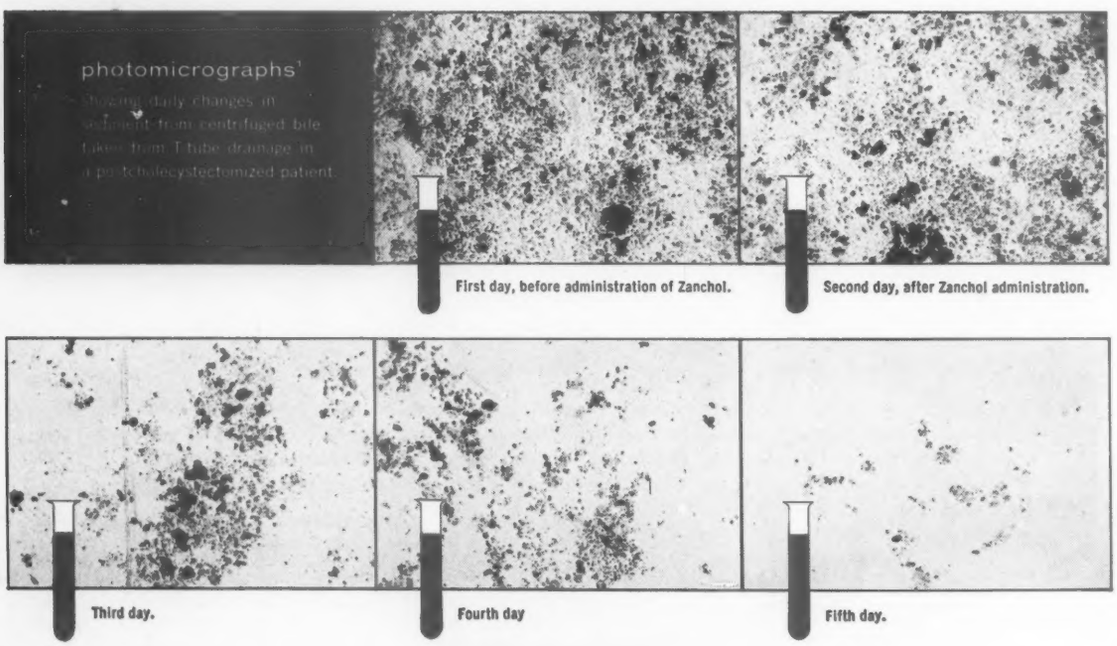
photomicrographs[1]
showing daily changes in sediment from centrifuged bile taken from T-tube drainage in a postcholecystectomized patient
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VICTOR R. JABLOKOW AND WILLARD C. MEYER

A case of leiomyoma of the epididymis is reported. Tumors of this kind are rare, and less than twenty cases have been reported to date.

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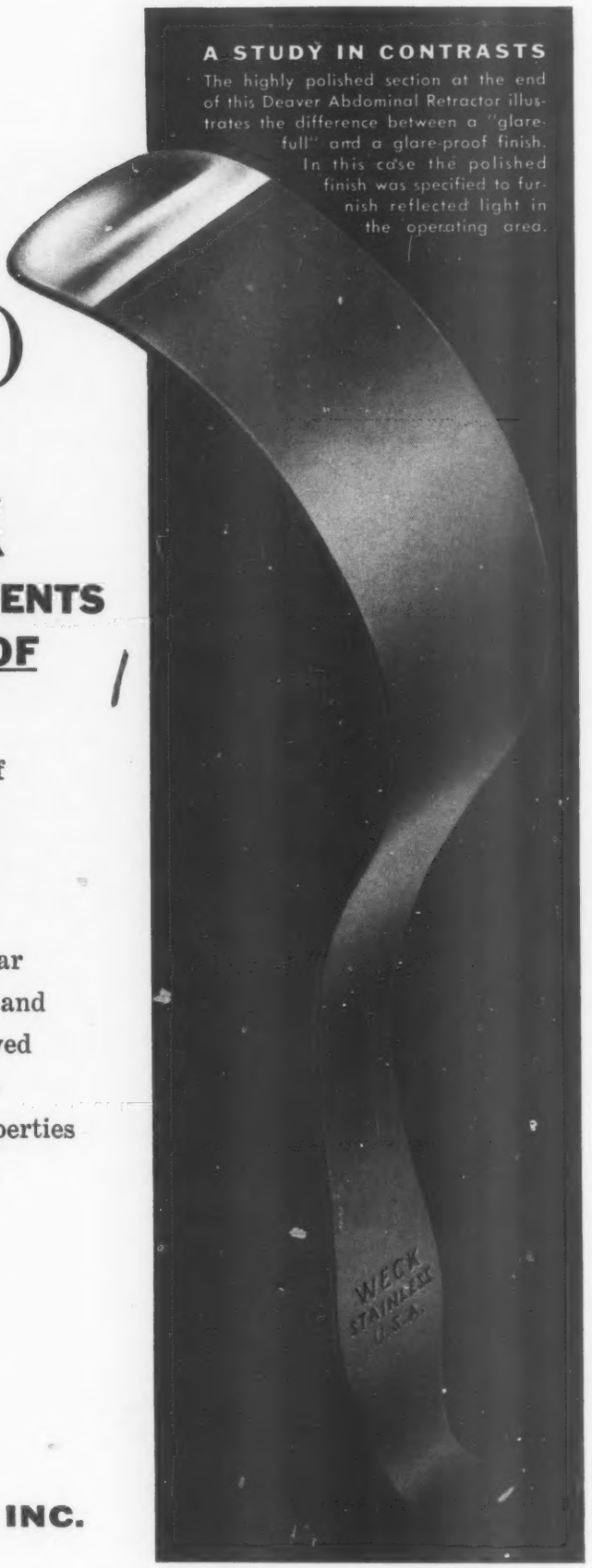


A STUDY IN CONTRASTS
The highly polished section at the end of this Deaver Abdominal Retractor illustrates the difference between a "glare-full" and a glare-proof finish. In this case the polished finish was specified to furnish reflected light in the operating area.

– an indication of the growing appreciation of the importance of eliminating the mirror-like glare of highly polished stainless steel instruments.

The Weck Glare-Proof Finish – far superior to the so-called "satin" and "black" finishes – has been achieved without sacrifice to the corrosion-resistant and ease-of-cleaning properties of standard Weck stainless steel.

Your inquiries are invited.

*name of hospital sent on request.

WECK

67 years of knowing how

EDWARD WECK & CO., INC.
135 Johnson Street, Brooklyn 1, New York

Manufacturers of Surgical Instruments • Hospital Supplies • Instrument Repairing

Weck Glare-Proof Instruments have been used in color television surgeries at National Congresses of the Amer. Coll. of Surgeons and the A. M. A.

Used in Tokyo, as it is everywhere,

Pentothal alone among intravenous anesthetics brings you a record of more than 20 years' world-wide use

TOKYO, BY GEORGE SUYEOKA

More than 2500 published reports confirm the many advantages that keep Pentothal Sodium an agent of choice in intravenous anesthesia. Among these advantages: quick response, moment-to-moment control, smooth induction, swift recovery. No other intravenous anesthetic agent has proved itself more thoroughly. Abbott

PENTOTHAL® Sodium

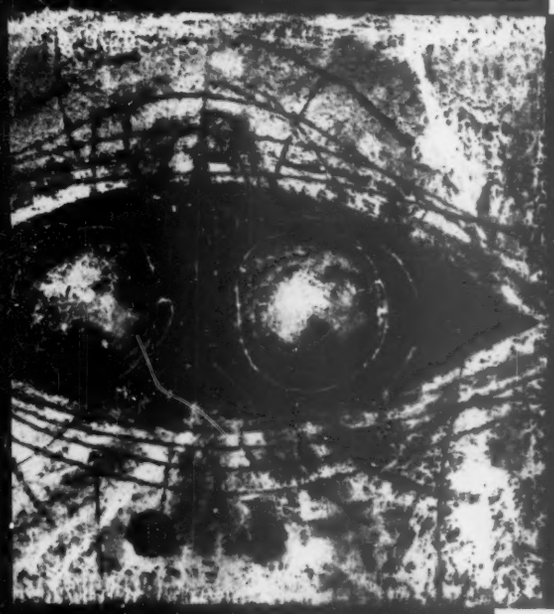
(*Thiopental Sodium for Injection, Abbott*)

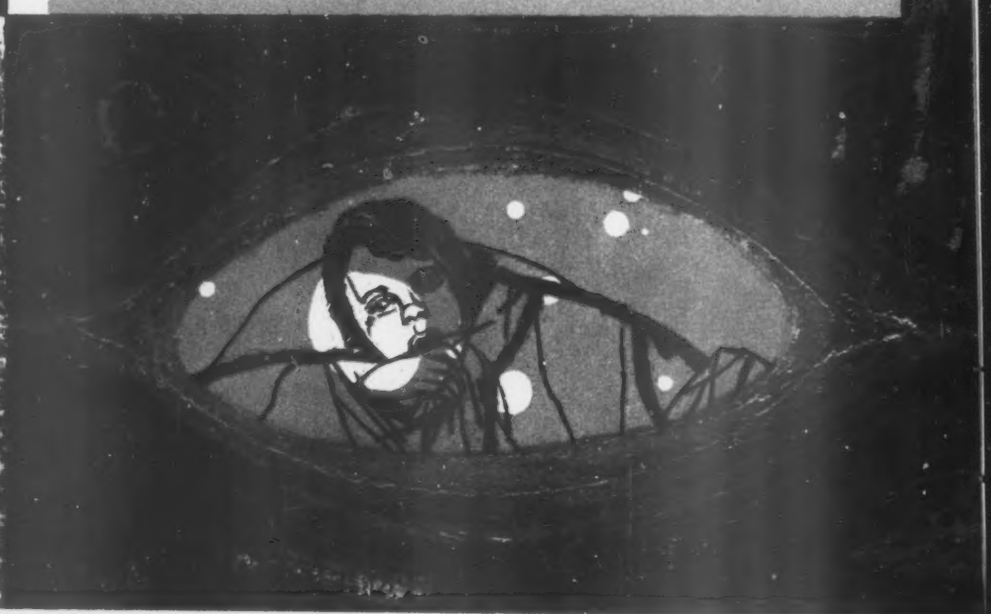
no pain...

no memory...

no nightmare of fear

in pediatric anesthesia

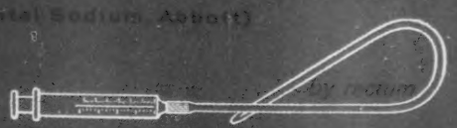


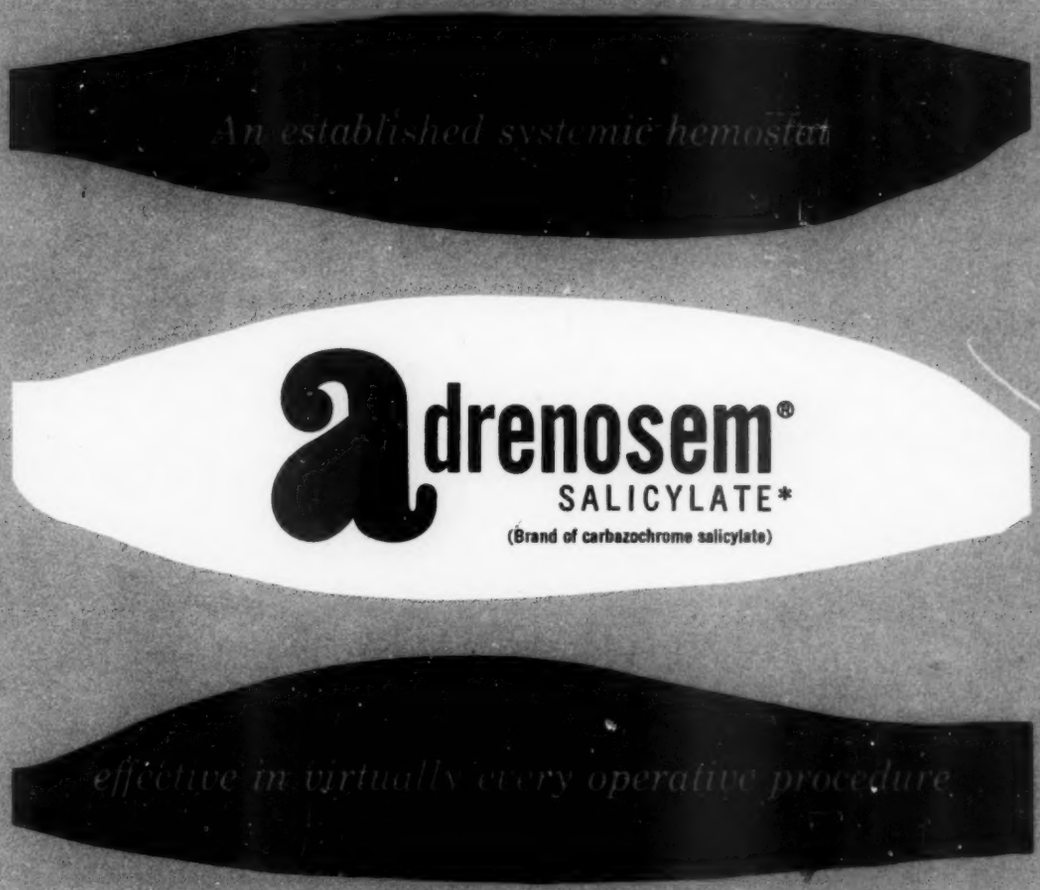


With Rectal Pentothal, children go to sleep in the comfort of their own room, awaken there afterward as from a dreamless, natural sleep. Thus, there is neither preoperative apprehension nor postoperative behavior problems. By using Rectal Pentothal you can reduce the dosages of inhalation and supplementary agents, markedly lessening the need for postoperative nursing care. In studies of 4000 cases, Rectal Pentothal has proved to be a simple, humane and notably safe approach to pediatric anesthesia. Do you have the literature? Abbott

PENTOTHAL® Sodium

(Thiopental Sodium, Abbott)





The reports of numerous investigators have established the effectiveness of Adrenosem Salicylate in the control of bleeding. It has been used prophylactically and therapeutically in virtually every operative procedure. Following are some of the procedures and conditions where its usefulness has been demonstrated:

Tonsillectomy, adenoidectomy and nasopharynx surgery
Prostatic, bladder and transurethral surgery
Excessive postpartum bleeding and uterine bleeding
Thoracic surgery
Plastic surgery
Gastrointestinal bleeding

ALSO:
Idiopathic purpura
Epistaxis
Retinal hemorrhage
Hematuria
Hemoptysis
Familial telangiectasia
Pulmonary bleeding
Metrorrhagia and menorrhagia

*U.S. Pat. 2581850; 2506294

THE S. E. MASSENGILL COMPANY
Bristol, Tennessee
New York • Kansas City • San Francisco

One of the many uses of **adrenosem®**
SALICYLATE

Adrenosem Salicylate is useful in every operative procedure where bleeding and oozing are problems. This hemostatic agent controls blood loss by maintaining normal capillary permeability and by promoting the retraction of severed capillary ends.

One clinician states: "At the recommended dosage levels there are no contraindications. Patients treated for more than two years show no toxic effects attributable to the drug."[1]

Adrenosem Salicylate is supplied in

Ampuls
Tablets
and as a Syrup

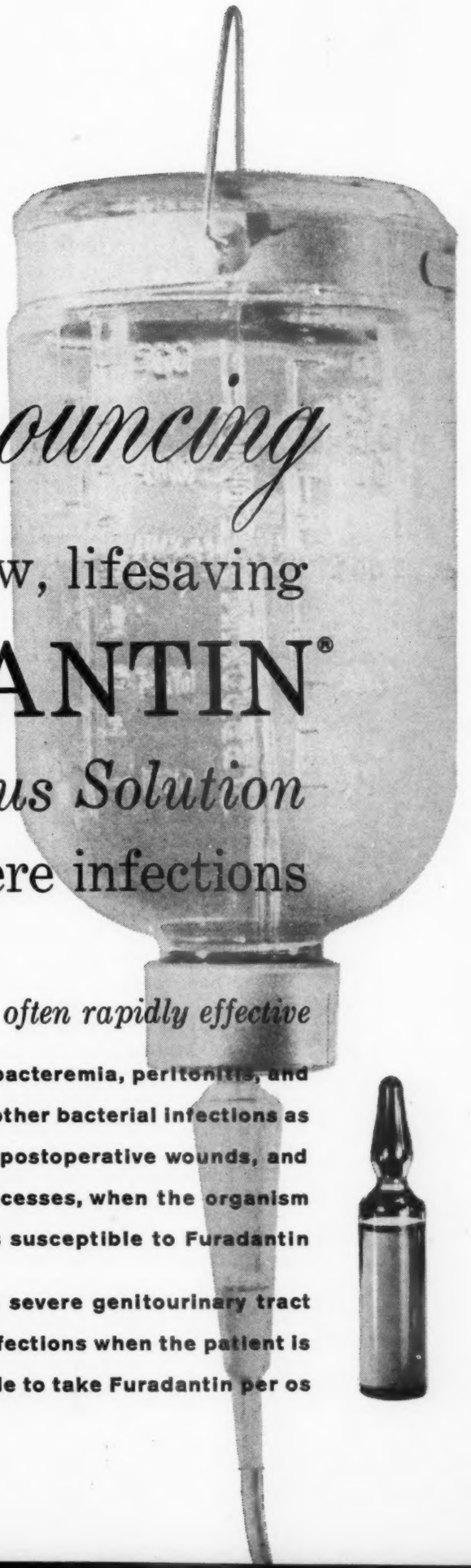
1. Ruddle, A.C., Jr.: Adrenosem Salicylate: A Systemic Hemostat, Oral Surg., Oral Med., Oral Path. 6:617 (June, 1953).

Vaginal hysterectomy. Without Adrenosem. Note bloody field.

Vaginal hysterectomy. With Adrenosem. Note dry field.

Write for comprehensive illustrated brochure describing clinical uses of Adrenosem Salicylate

THE S. E. MASSENGILL COMPANY
Bristol, Tennessee
New York · Kansas City · San Francisco



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new, lifesaving

FURADANTIN®

brand of nitrofurantoin

Intravenous Solution

for severe infections

often rapidly effective

- **in bacteremia, peritonitis, and other bacterial infections as of postoperative wounds, and abscesses, when the organism is susceptible to Furadantin**
- **in severe genitourinary tract infections when the patient is unable to take Furadantin per os**

EATON LABORATORIES

NORWICH. NEW YORK

OFFICE OF THE MEDICAL DIRECTOR

Dear Doctor:

For your postoperative or severely ill patients unable to take antibacterial medication by mouth, Eaton Laboratories announces the availability of FURADANTIN INTRAVENOUS SOLUTION.

Furadantin I.V. is proving highly effective in refractory bacterial infections such as bacteremia and peritonitis, and other bacterial infections as of postoperative wounds and abscesses, when the organism is susceptible to Furadantin. In addition, Furadantin I.V. provides an important alternate route of administration for treating genitourinary tract infections in patients unable to take medication by mouth.

The results of clinical studies indicate that Furadantin Intravenous Solution should be tried in certain bacterial infections, refractory to other medicaments, when caused by organisms sensitive to Furadantin. In 75 extra-urinary tract infections including bacteremia, peritonitis, pneumonia, osteomyelitis and abscesses, 34% were cured with Furadantin Intravenous Solution, and an additional 45% were significantly improved.

Side reactions similar to those with oral Furadantin have been encountered, but no serious side effects have been observed in either adults or children.

Furadantin Intravenous Solution not only fills a long-felt need in the treatment of refractory urinary tract infections, but offers new hope in selected, severe systemic infections; even in those which have failed to respond to all other drugs. We are confident that Furadantin I.V. will play an important role in the treatment of your hospitalized patients with severe infections.

Sincerely,

Paul F. MacLeod, M.D.
Medical Director

FURADANTIN I.V.

FURADANTIN I.V. in severe urinary tract infections

No. Cases	Cured	Improved	Failed
71	37 (52%)	28 (39%)	6 (8%)

FURADANTIN I.V. in extra-urinary tract infections

	No. Cases	Cured	Improved	Failed
Peritonitis	6	3 (50%)	2 (33%)	1 (16%)
Bacteremia	23	12 (52%)	6 (26%)	5 (22%)
Postoperative Wound Infection	18	4 (22%)	11 (61%)	3 (16%)
Others (pneumonia, meningitis, osteomyelitis, otitis media, etc.)	28	7 (25%)	15 (53%)	6 (21%)
Total	75	26 (34%)	34 (45%)	15 (20%)

In the following representative cases of urinary tract and extra-urinary tract infections—cases ranging from "severe" to "hopeless"—intravenous administration of Furadantin achieved clinical and bacteriologic cure or marked improvement in a high percentage. Often, a wide variety of antibiotics and sulfonamides had failed to control the infection.

Case Summaries

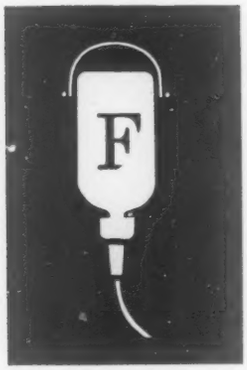
Sex; Age; Disease Treated	Causative Bacterium	Coexisting Disorder
M; chronic cystitis, pyelonephritis	Ps. aeruginosa in urine	---
F; chronic pyuria with fever	E. coli in urine	---
F; 39; pyelonephritis	Ps. aeruginosa in urine	Staghorn calculus, right
M; 79; bacteremia	E. coli in urine	Post-transurethral resection
F; pyuria, probable bacteremia	A. aerogenes in urine. Blood culture--neg.	Post-panhysterectomy
M; pyelitis, probable bacteremia, chills	E. coli, Ps. aeruginosa	Bilateral renal calculi
Bacteremia	Blood culture positive	Psychosis

FURADANTIN I.V.

Furadantin I.V. Dosage	Result of Treatment	Remarks
180 mg. daily, 3 days	Cured	Resistant to broad spectrum antibiotics and sulfonamides. In 3 days, afebrile; urinary frequency, urgency gone, urine culture negative.
180 mg. daily, 4 days	Cured	Resistant to penicillin and sulfonamides. In 4 days, "afebrile and infection cleared," urine culture negative.
60 mg. q. 8 h., 3 days	Cured	Organism resistant in vitro to Furadantin. Changed to oral form after 3 days on I.V.
360 mg. q. 8 h. for 3 doses, then 180 mg. b.i.d., 2 days	Cured	36 hours post-op.temp. 106.4°. Remission of fever 16 hours after starting Furadantin I.V. Negative urine culture in 5 days.
180 mg. b.i.d., 3½ days	Cured	Antibiotics for 2 weeks. Added oral Furadantin 4 days. Patient semi-comatose when Furadantin I.V. started. Afebrile in 24 hours. Urine culture sterile at 14th day.
180 mg. q.i.d., 5 days	Cured	When Furadantin I.V. started temp. 104°. In 24 hours, temp. 99°. Previous treatment included penicillin, streptomycin and sulfonamide for 5 days each. Patient discharged on oral Furadantin for 5 days. Returned to clinic with negative urine.
180 mg. daily, 2 days	Inconclusive, blood culture negative	"Patient had been resistant to penicillin and streptomycin." Chlortetracycline given intercurrently with Furadantin I.V.

Sex; Age; Disease Treated	Causative Bacterium	Coexisting Disorder
M; empyema and post-surgical wound infection	Pseudomonas sp.	Pulmonary TB, pneumonectomy
M; 75; acute pyelonephritis	None isolated from blood or urine but gross pus in urine	Prostatectomy month before
F; 77; cystitis, atypical pneumonia	(Not stated)	Diabetes mellitus
F; furunculosis	M. pyogenes var. aureus	Post-pyelonephritis
M; 62; recurrent gross hematuria, pyuria	Proteus sp. in urine	Benign hypertrophic prostate
F; 69; peritonitis, bacteremia	E. coli in peritoneal fluid. Proteus sp. in blood	Cancer of colon with perforation, resection
M; 28; peritonitis, bacteremia	Proteus sp. in peritoneal fluid and blood	Ulcerative colitis, obstruction at ileostomy and perforation of small intestine. Resection of perforation and revised ileostomy. Shock
M; 76; pyelonephritis, cystitis	Proteus sp., A. aerogenes in urine	Bilateral renal calculi, uremia
3 weeks old infant; meningitis	E. coli in spinal fluid and urine	---

Furadantin I.V. Dosage	Result of Treatment	Remarks
180 mg. daily, 3 days	Improved	Previous streptomycin and INAH, pneumonectomy. Empyema and wound infection with Pseudomonas. After Furadantin I.V. temp. normal, wound improved. Continued on oral Furadantin.
180 mg. b.i.d., 2 days	Cured	Temp. 103° reduced to normal, urine clear and patient discharged in 2 days. ". . . without Furadantin I.V. . . . probably would have died."
180 mg. daily, 3 days	Cured	Penicillin-dihydrostreptomycin 5 days previous. Temp. 104.4° to normal 24 hours after Furadantin I.V. instituted.
180 mg. daily, 3 days	Markedly improved	Continued elevation in temp. (100-101°) for 10 weeks in spite of intensive antibiotic therapy. Temp. dropped slowly to normal on Furadantin I.V. and no new furuncles developed.
180 mg. daily, 3 days	Improved	Previous sulfonamide treatment 7 days. Bacterium resistant to all tested drugs, slightly sensitive to Furadantin. Temp. normal in 3 days. Followed with oral Furadantin 6 days. TUR following day. Uneventful post-op.
600 mg. daily, 4 days	Cured	Sensitive to chloramphenicol and Furadantin. Furadantin blood level 6-12.5 gamma/cc. Temp. subsided in 24 hours. Culture sterile in 4 days and no drainage. Patient discharged in 2 weeks.
600 mg. daily, 5 days	Cured	Sensitive to chloramphenicol and Furadantin. Furadantin blood level 12.6 to 14.2 gamma/cc.
240 mg. daily, 4 days	Cured	Oral Furadantin ineffective. With Furadantin I.V., cultures became sterile. Furadantin blood levels 2.9 to 6.2 gamma/cc.
3.3 mg./Kg. q. 12 h. for 5 doses	Cured	Fever 2 days. Received antibiotics and sulfonamides. Temp. 103° became normal in 16 hours following institution of Furadantin I.V. and remained so for duration of hospitalization.



FURADANTIN *Intravenous Solution*

DOSAGE AND ADMINISTRATION: Furadantin Intravenous Solution contains 0.6% Furadantin, dissolved in polyethylene glycol 300. Each 10 cc. ampule contains 60 mg. of Furadantin. The solution is sterile and must be dissolved aseptically in a sterile diluent prior to use.

The recommended diluent is 5% dextrose solution. Furadantin Intravenous Solution is compatible with normal saline and ⅙ M sodium lactate solutions, but these should be used only when definitely indicated because of the possibility of further disturbing an already upset electrolytic balance. Administer as an intravenous drip at a rate indicated for the patient's general condition and age. The suggested dosage is 5 to 7 mg. per Kg. body weight (2.2 to 3.1 mg./lb.) per 24 hours in 2 divided doses. The single dose of Furadantin Intravenous Solution for the average adult is 30 cc. (3 ampules or 180 mg.) in at least 500 cc. of diluent. If tolerated, this is repeated so that 2 such doses (360 mg.) are given over 24 hours and continued for 7 days, if necessary. Following are average dosage schedules:

Weight of Patient	*Size of Single Dose*	*Minimal Amount of Diluent*
120 lbs. or over (54 Kg.)	30 cc. (3 amp.) = 180 mg.	500 cc.
80 to 120 lbs. (36-54 Kg.)	20 cc. (2 amp.) = 120 mg.	350 cc.
40 to 80 lbs. (18-36 Kg.)	10 cc. (1 amp.) = 60 mg.	175 cc.

In urinary tract infections, the intravenous form may be replaced by the oral dosage form of Furadantin when sufficient improvement has resulted and patient can take medication orally.

SIDE REACTIONS: Nausea or emesis may occur occasionally. These are often minimized by a decrease in dose rate. Sensitization occurs rarely in the form of urticaria or an erythematous, maculopapular rash. This may be controlled by discontinuing treatment immediately and employing the usual measures such as epinephrine, antihistaminics or adrenocorticosteroids. Occasionally patients may show minor side reactions such as headache or malaise. No stomatitis, colitis, proctitis, anal pruritus, monilial superinfection, staphylococcic enteritis or renal, hepatic or hemic toxicity have been reported.

With intravenous administration, it is important to be alert to the possibility of central nervous system effects such as muscular twitching or spasticity. Should this occur, calcium gluconate should be administered intravenously and Furadantin discontinued. Adequate amounts of vitamin B complex and vitamin C should be supplied to the patient on intravenous Furadantin therapy.

SUPPLIED: Sterile 10 cc. ampules (60 mg. Furadantin each), box of 12.

NOTE: Furadantin Sensi-Discs (100 mcg.) for sensitivity testing are available from the Baltimore Biological Laboratories. Materials and instructions for serial-tube dilution tests may be obtained from the Medical Director of Eaton Laboratories. To simplify sensitivity testing with Furadantin and to provide maximum reproducibility and reliability, Eaton Laboratories has prepared a new booklet, "Bacterial Sensitivity Testing with Furadantin and Furacin," copies of which may also be obtained by writing to the Medical Director.

For oral administration in the treatment of genitourinary tract infections: Furadantin tablets, 50 and 100 mg.; Furadantin Oral Suspension, 25 mg. per 5 cc. tsp.

NITROFURANS—*a* new *class of antimicrobials—neither antibiotics nor sulfonamides*

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No. 2 of an operative series—for details, see next page

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'CREST' Brown Milled Surgeons' Gloves by SEAMLESS

Unmatched for eye, brain, cardiac and vascular surgery.

The ultimate in sensitivity and comfort—47 per cent thinner and softer than ordinary surgical gloves.

Non-skid surface affords more positive handling when wet.

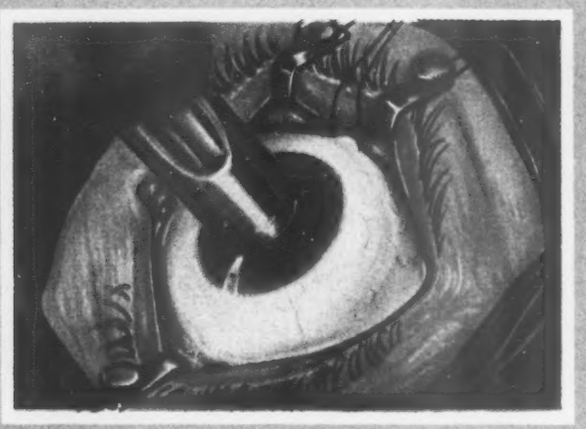
Hypoallergenic properties minimize the possibility of contact dermatitis.

***NOTE:** *Not recommended for general surgery because they are so extremely thin.*

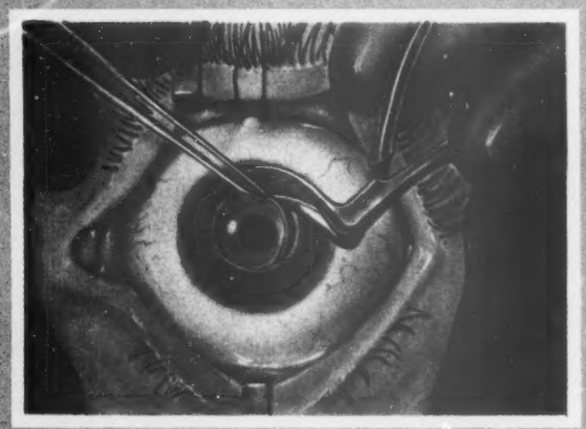
Dust with 'EZON' the superior, non-inflammatory, rubber lubricating powder for all surgical gloves

KEY ADVANCES IN OPERATIVE TECHNICS*—*Corneal Graft*[1]

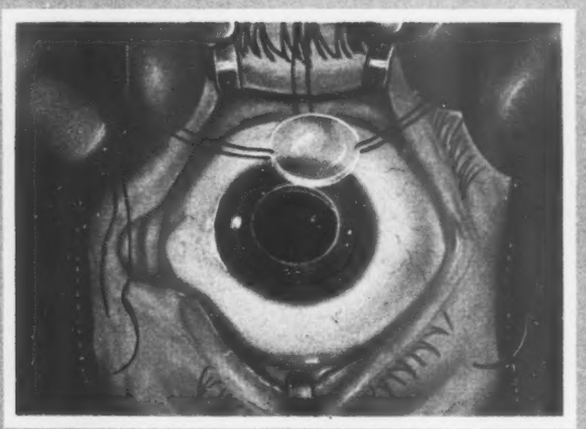
1. A corneal graft of appropriate size is cut from the donor eye with a Castroviejo trephine. Inset shows excised button of healthy corneal tissue.



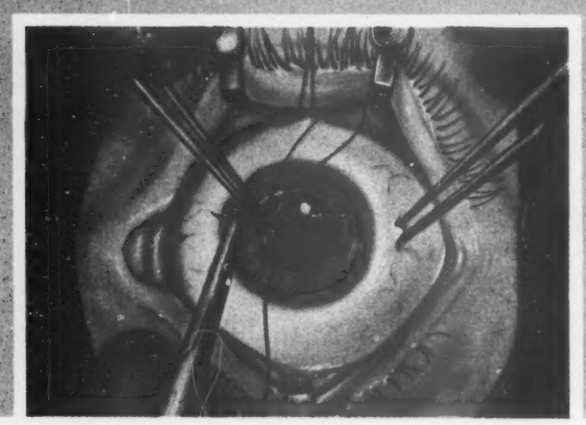
2. The site of excision of the patient's diseased cornea is marked with a trephine of the same size as that used to obtain the donor graft.



3. As soon as the anterior chamber is entered, the trephine is withdrawn and the excision is completed with Castroviejo curved scissors. This procedure avoids damaging the iris.



4. Following removal of the diseased corneal tissue, the donor button is brought to the open incision with two preplaced sutures. The graft is then accurately positioned.



5. Sutures are placed with Castroviejo No. 82 stainless steel Grishaber needle and 6-0 silk. They pass through the epithelium and stroma and are continued through the recipient cornea and tied.

6. Appearance of completed keratoplasty after placing of final four sutures. Air may now be injected into anterior chamber to minimize the development of anterior synechia.

Corneal graft is one of a series of surgical drawings in color illustrating an important procedure perfected during the past decade. It is brought to you as a service by Seamless, the world's largest manufacturer of surgeons' gloves. If you would care to examine any of the Seamless Gloves . . . 'Crest', Brown Milled, or White or Brown 'Limber-Latex', write for a sample giving your glove size.

**Based on an opinion survey of 2,500 general surgeons.*

1. Castroviejo, Ramon, *Trans. Am. Ophth. Soc.*, Eighty-fifth Annual Meeting, Hot Springs, Virginia, 1949.

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References: 1. Gamble, J.R., et al. Arch. Int. Med. 95:52, 1955. 2. Gamble, J.R., et al. J. Lab. & Clin. Med. 42:805, 1953.

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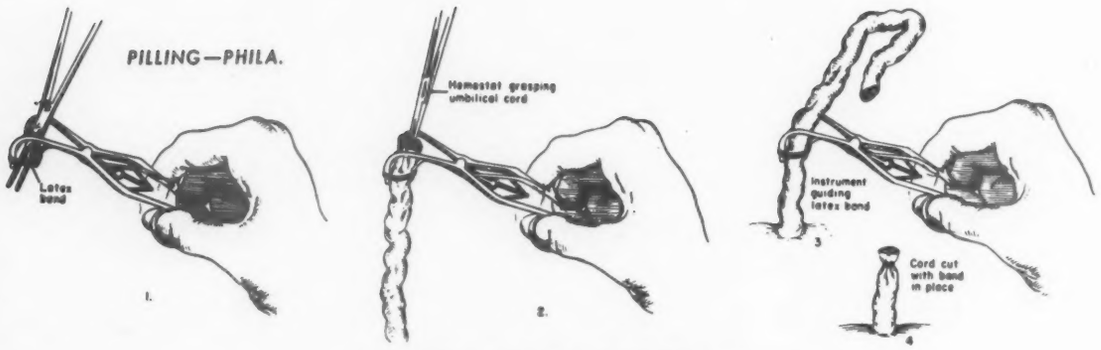

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The carrier makes a triangular-shaped opening in the latex band allowing for passage of even the largest cords.

TECHNIC:

1. Spread the instrument with attached band, pass a hemostat through the triangular opening.

2. Grasp the cord with the hemostat and pull through the band.

3. Release the band on the cord approximately 1-1/2" from the newborn's abdomen.

4. Section the cord 1" distal to the band. (The band remains until the cord separates from the abdomen.)

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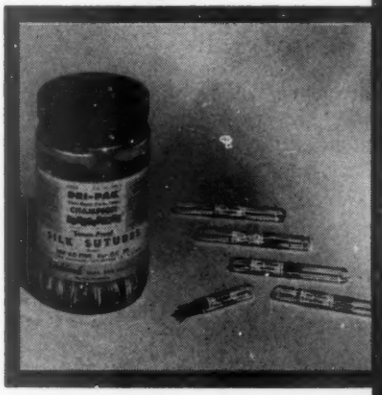

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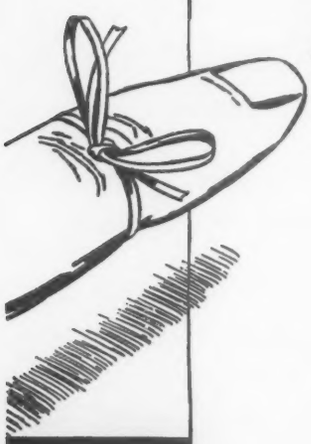

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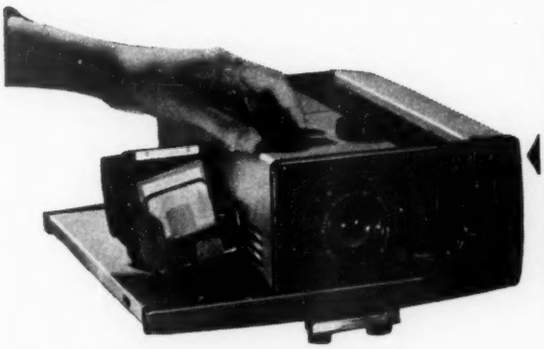

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NEW INTRAMUSCULAR IRON PROVIDES PRECISION THERAPY, PROMPT RESPONSE

IMFERON,® the new intramuscular iron-dextran complex, was introduced to American hematologists at the Sixth International Congress of the International Society of Hematology held in Boston, August 27 to September 1, 1956. Recent experience from over 6 million injections has shown that this iron preparation is easy to administer, notably free from toxic effects, quickly absorbed and productive of rapid hematologic and clinical improvement. It has been termed "...the only therapeutically effective iron preparation for intramuscular use...."[1]

IMFERON meets the need for a safe, effective agent when parenteral iron is preferable for patients with iron deficiency anemia who are resistant or intolerant to oral iron, those with depleted iron reserves and those who require rapid restoration of hemoglobin, *e.g.* last trimester of pregnancy.

Previous parenteral iron preparations were unsatisfactory because of toxicity, pain on injection, or because they contained insufficient iron. IMFERON contains the equivalent of 5 per cent elemental iron. It is more stable than iron saccharate both *in vitro* and *in vivo* and does not precipitate in plasma over a wide pH range. It is isotonic with tissue fluids and has a pH of 5.2 to 6.0[1] Utilization for hemoglobin formation is almost quantitative.

Precision Therapy with IMFERON: Before treating a patient with IMFERON, total iron requirement is calculated by formula or determined from a convenient dosage chart. Then appropriate amounts of IMFERON are injected daily or every other day, until the total calculated required amount is given.

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Iron Deficiency Anemia of Pregnancy: Nausea precludes oral iron therapy in many anemic pregnant women. In those with severe anemia who are first seen late in pregnancy, prompt hemoglobin regeneration is unobtainable with oral iron. IMFERON produced prompt hemoglobin responses in anemia of pregnancy,[5,6] the results being similar to those obtained with intravenous saccharated iron oxide. Side effects were virtually absent with IMFERON.[5,6]

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Present Studies: Published reports and recent findings of clinical investigators confirm the effectiveness and safety of IMFERON for hemoglobin regeneration and creation of iron stores. More than 70 studies are now being completed in the United States. Reports stress prompt hemoglobin response, ease of administration and freedom from side effects. Clinicians desiring additional information should request Brochure No. NDA 17, IMFERON, Lakeside Laboratories, Inc., Milwaukee 1, Wisconsin.

References: (1) Brown, E. B., and Moore, C. V., in Tocantins, L. M.: Progress in Hematology, New York, Grune & Stratton, Inc., 1956, vol. I, p. 25. (2) Gaisford, W., and Jennison, R. F.: Brit. M. J. 2:700 (Sept. 17) 1955. (3) Wallerstein, R. O.: J. Pediat. *49*:173, 1956. (4) Sturgeon, P.: Pediatrics *18*:267, 1956. (5) Jennison, R. F., and Ellis, H. R.: Lancet 2:1245 (Dec. 18) 1954. (6) Scott, J. M., and Govan, A. D. T.: Brit. M. J. 2:1257 (Nov. 27) 1954. (7) Grunberg, A., and Blair, J. L.: A.M.A. Arch. Int. Med. *96*:731, 1955. (8) Millard, J. B., and Barber, H. S.: Ann. Rheumat. Dis. *15*:51, 1956. (9) Baird, I. M., and Podmore, D. A.: Lancet 2:942 (Nov. 6) 1954. (10) Cappell, D. F.; Hutchinson, H. E.; Hendry, E. B., and Conway, H.: Brit. M. J. 2:1255 (Nov. 27) 1954. (11) Stevens, A. R.: A.M.A. Arch. Int. Med. *96*:550 1956.

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VOLUME 94 JULY 1957 NUMBER ONE

EDITORIAL

The Use and Abuse of Inert Materials in Hernia Repair

In recent years there has been a marked increase in the use of inert materials or implants in surgical procedures. This trend is apparent in all branches of surgery and I believe it is appropriate that some of the harmful or deleterious effects of these substances be reviewed. I wish to confine my present remarks to the use of these materials in the repair of hernias. The medical literature is replete with reports extolling the advantages of such materials as tantalum, stainless steel, nylon, dacron and fortisan fabric in the repair of various types of hernias. There is a serious lack of accurate statistical information or clinical experience with these various types of implants.

Basically, the repair of any hernia requires only the reduction of the hernial contents, obliteration of the sac and finally closure of the hernial orifice.

There is general agreement that the use of the patient's own tissues in closing the hernial defect offers the best hope of effecting a permanent cure of the hernia. Every foreign body causes a certain amount of tissue reaction and this reaction always impedes the normal delicate healing process. If this reaction is extensive and a considerable accumulation of serum occurs which requires frequent aspirations, infection is very likely to occur predisposing to recurrence of the hernia.

There is no doubt in my mind that these various implants have been used too indiscriminately in recent years. In many years' experience at the Ruptured and Crippled Hospital, I can recall very few cases of incisional hernias in which the patient's own tissues could not be used to close the defect in the abdominal wall. To be sure, some of these repairs were more secure than others, but even in those cases in which the patient's own tissues left something to be desired, I am certain the use of the various meshes would not have significantly improved the repair.

There is no excuse for the use of these implants in the repair of inguinal hernias. In this type of hernia the best chance of a cure is in the use of one of the conventional types of repair, aided when necessary by either transection of the cord or orchidectomy.

In the past few years I have had occasion to reoperate on many patients who were unfortunate enough to have had some type of inert substance used in the repair of their hernias. Their recurrent hernias with multiple draining sinuses have presented real problems. After reoperating on these patients, I have invariably been convinced that the implants were not indicated in the first operation since it was possible to repair these recurrent hernias by using one of the conventional methods of repair. Sound surgical judgment is still the prime prerequisite of the good surgeon. It is my conviction that its absence has been clearly demonstrated in most of the patients who have come under my care following the use of these various implants, and their indiscriminate use in the repair of hernias should be condemned.

ROLAND L. MAIER, M.D.,
New York, New York

Long Term Survival Following Right Hepatic Lobectomy

ALEXANDER BRUNSCHWIG, M.D., *New York, New York*

From the Memorial Center for Cancer and Allied Diseases, New York, New York. Compilation of the data herewith published was made possible by a grant from the James S. and Marvel Adams Foundation, Greenwich, Connecticut.

THE frequency of radical operations on the liver is increasing although the general principles of hepatic surgery were established in the latter part of the last century and the first two decades of this century. The purpose of this report is to record four instances of right hepatic lobectomy, all these patients are surviving in good condition five or more years. These patients have been mentioned previously in the literature but only in conjunction with discussions concerning the feasibility of right hepatic lobectomy [1,2]. The factor emphasized in this report is that longevity in normal status can be expected following such radical surgery for both benign and malignant hepatic neoplasms.

The conception of what constitutes a right lobectomy is not entirely clear because of the difference between the classic gross anatomic description of the right lobe and the definition of the right lobe based upon vascular injections reported some years previously and again described in the recent literature. According to the classic gross anatomic description, all liver tissue to the right of the falciform ligament is regarded as the right lobe. Actually the quadrilateral portion to the left of the gallbladder fossa and to the right of the falciform ligament, and bounded above by the porta hepatis is a separate lobe—the quadrate lobe. Vascular injection studies would indicate that there is an appreciable variation in the number and course of the large vessels and these determine a true lobar organization. Thus, based upon the internal arterial organization, the right lobe is comprised of five smaller lobes according to Couinaud and six smaller lobes according to Healey and Schroy. Hjortojo states that the glissonian system delineates a right half, a left half and a mesial segment of the liver. A detailed discussion of the internal vascular and true lobar organization of the liver has been presented by Gans [3].

In the present report, however, the time-honored custom of referring to the right lobe as that portion to the right of the falciform ligament will be adhered to. A truly complete right hepatic lobectomy would not appear to be feasible, that is, perpendicular amputation of all hepatic tissue to the right of and actually in the plane of the falciform ligament, because of interference with the main vascular supply of the left lobe which is in the porta hepatis.

GENERAL PRINCIPLES OF TECHNIC

In the case of so-called total right hepatic lobectomies, two general principles of excision are described: (1) immediate transection of the lobe through its base, about 2 to 3 cm. to the right of the falciform ligament, by a combination of progressive sharp and dull dissection employing compressing mattress sutures as needed on the stump side of the incision and clamping of vessels and large bile ducts as they are encountered; and (2) the so-called controlled method of first isolating, transecting and

dividing the large arterial and venous (portal) branches to the lobe in the portahepatis, and the transection and ligation of the large hepatic veins as they exit from the liver to join the inferior vena cava. In the second procedure, when vascular channels are interrupted, most of the right lobe rapidly exhibits a dark, cyanotic appearance and the transection is carried out through the base in normal-appearing parenchyma 1 to 3 cm. away from the cyanotic border.

The choice as to which method to use is up to the surgeon. Both procedures can be performed satisfactorily. In the four patients described herein, the direct transection (or guillotine) procedure was followed because by this method lobectomy may be performed without opening the right thoracic cavity. In the controlled method, extension of the abdominal incision through the right costal arch to open the thorax is necessary for forward mobilization of the right hepatic lobe in order to secure and transect the deep hepatic veins coursing from the deep posterior aspects of the liver into the inferior vena cava, before transection of hepatic parenchyma is attempted.

I have performed right hepatic lobectomy by the controlled principle, but none of the patients reported herein were operated on in this manner. In fact, on the basis of my experience, I believe that the likelihood of morbidity is reduced if the right thoracic cavity is not entered. However, there is no question that mobility of the right lobe is greatly facilitated and exposure of the operative field is enhanced if the thoracoabdominal incision is employed. Right hepatic lobectomy by the "guillotine method" and not by means of a thoracoabdominal incision is more difficult, and because of reduced exposure and more limited mobilization of the right lobe, accidental hemorrhage is more difficult to cope with.

CASE 1.* E. J., a fifty-three year old woman, was conscious of the presence of an epigastric mass which had increased in size during the previous three years. She also had ill-defined episodes of epigastric pain, occasional nausea and vomiting and temperature elevations to 102°F. In 1948 laparotomy had been performed and a large mass was seen attached to the anterior aspect of the right lobe of the liver. After a biopsy specimen was taken (proved to be hemangioma), further procedure was abandoned because of hemorrhage. Menorrhagia had been present for several years. She also had undergone myomectomy ten years previously.

Physical examination on the present admission revealed a woman who appeared younger than her stated age. A large, firm mass occupied the upper abdomen, mostly on the right, and measured roughly 25 by 14 cm. It seemed fixed to the upper anterior abdominal wall, on which there was a long transverse scar. The mass was smooth, non-tender and very hard. No thrill was audible or palpable. Pelvic examination revealed an enlarged movable uterus with coarse nodulosity. The uterine sound revealed an endometrial cavity 12 cm. in length. Laboratory studies were not relevant.

On January 4, 1951, exploratory laparotomy was performed through a high, midline incision. The procedure was complicated by the fact that the deeper layers of the anterior abdominal wall were densely adherent to the protruding portions of the tumor. When the mass was finally exposed, by lateral incisions to liberate a portion of the abdominal wall left adherent to the mass, it was found to arise from the anterior aspect of the liver and had replaced the major portion of the liver. The mass itself was grossly recognizable as a cavernous hemangioma, and its surfaces presented numerous areas of cicatrization. At one point the hemangioma was inadvertently incised and considerable oozing of blood occurred, but this was controlled by gauze packs. When all fibrous and mesenteric attachments had been severed (the transverse colon was mobilized and retracted downward), the broad attachment to the liver was evident. A sharp line of demarcation was visible between the hemangioma and the liver parenchyma. Large mattress sutures of No. 2 chromic catgut were placed into the liver parenchyma just beyond the margins of the tumor, and tied. (Fig. 1.) By rapid sharp dissection liver tissue was incised transversely and wide of the margin of the growth. Considerable oozing of blood developed. Individual pulsating vessels, large veins and bile ducts were clamped and tied. The incision began on the right and proceeded to the left extremity of the hepatic attachment. The cystic duct was clamped, ligated and transected to remove the gallbladder with the tumor; the lower portion of the falciform ligament and adherent

* Previously cited [2].

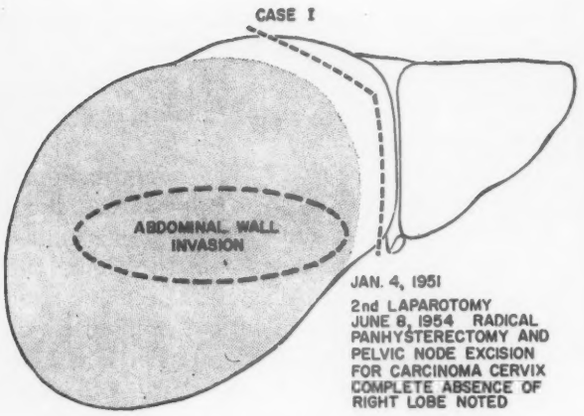
CASE I
ABDOMINAL WALL INVASION
JAN. 4, 1951
2nd LAPAROTOMY
JUNE 8, 1954 RADICAL PANHYSTERECTOMY AND PELVIC NODE EXCISION FOR CARCINOMA CERVIX
COMPLETE ABSENCE OF RIGHT LOBE NOTED

FIG. 1.

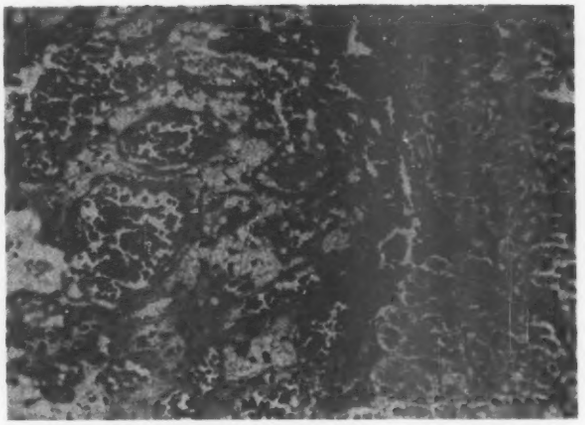

FIG. 2. Case 1. Photomicrograph of hemangioma of right lobe of liver.

elliptic portion of attached deep abdominal wall were also resected. Bleeding from the raw cut surface of the liver was arrested by pressure with gauze packs. It became evident that a crescent-shaped portion of liver tissue, about 8 cm. long, 6 cm. wide and 1 to 2 cm. thick, remained in the upper right portion of the resection field. In the great rush to terminate the operation it was the impression that about half the upper mesial portion of the right lobe remained; this was reported previously [2].

The patient was then placed in Trendelenburg position and the pelvis inspected. The uterus was enlarged to slightly more than fist size and exhibited rounded fibroids 2 to 4 cm. in diameter. The adnexae were negative. Prior to operation the patient emphatically requested that hysterectomy was not to be performed unless absolutely necessary. In view of the fact that an extensive upper abdominal procedure had been performed and there was no evidence of malignant neoplasm in the pelvis, hysterectomy was not carried out. Appendectomy was rapidly performed and the abdomen closed. A gauze pack was placed with pressure against the liver surface and a soft rubber drain was inserted in the region of the ligated cystic duct.

The excised right lobe measured 22 by 15 by 11 cm. and weighed 1,650 gm. Attached to the anterior aspect was an elliptic segment of deep fascia from the anterior abdominal wall measuring 11 by 9 cm. Histologic study was reported as "hemangioma, chiefly cavernous." (Fig. 2.) As stated previously, this case was previously reported by me as a partial right hepatic lobectomy [2] but on subsequent reflexion it was felt that almost all of the right lobe was resected and the portion remaining was but a narrow rim of liver parenchyma in the upper mesial portion of the right lobe. This impression was amply confirmed on June 3, 1954, when laparotomy was again performed for carcinoma, stage 1, of the uterine cervix. Radical panhysterectomy and pelvic node excision were performed. On this occasion the upper abdomen was explored and the absence of the entire right lobe determined. The small segment of liver tissue remaining, as described previously, apparently had atrophied completely.

On March 1, 1957, six years and two months after right hepatic lobectomy, the patient remains well.

Three years after right hepatic lobectomy the following blood chemistries were obtained: plasma protein, 6.3 gm. per cent; chlorides, 106 mEq./L; CO_2, 25 mEq./L; urea nitrogen, 6.8 mg. per cent; alkaline phosphatase, 2.7 mg. per cent; cephalin flocculation test, negative; sodium, 141 mEq./L; potassium, 4.14 mg./L; prothrombin time, 14.5 seconds.

CASE II. M. C., a thirty-nine year old woman, was in good health until November, 1951, when attacks of chills and fever developed. She was admitted to another hospital for study where it was observed that the right lobe of the liver was enlarged. A needle biopsy of the liver was performed, and because of evidence of internal hemorrhage, laparotomy was performed as an emergency procedure. The enlargement of the right lobe was then determined to be due to a hemangioma. Hemorrhage was arrested and the abdomen closed.

On February 11, 1952, I performed a second laparotomy through an upper abdominal trans-

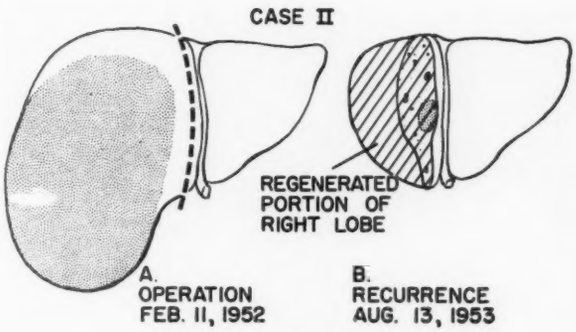

FIG. 3.

verse incision. (Fig. 3A.) A bulky hemangiomatous mass was noted bulging mainly posteriorly, but having replaced almost the entire right lobe. The anterior edge of the right lobe extended downward to the level of the iliac crest. The left lobe was enlarged to about twice normal size and on manual pressure seemed to collapse considerably.

All ligamentous attachments of the right lobe were divided and the lobe brought well forward into the laparotomy wound. There was a zone of normal-appearing liver parenchyma between the falciform ligament and macroscopic edges of the neoplasm. This zone was crescent-shaped, extending a short distance on to the diaphragmatic surface of the liver. A cleavage plane was developed between neoplasm and normal parenchyma by means of sharp and blunt dissection. Large vessels and bile ducts were individually clamped and ligated as the transection progressed. The gallbladder was loosely attached and was comcompletely liberated from the right lobe and retracted downward to remain *in situ*. When the right lobe was completely removed, the remaining base of the lobe was about 2 to 3 cm. in width to the right of the falciform ligament. Large mattress sutures were inserted to compress the narrow remaining base of the right lobe. Tamponment of the large void occupied by the right lobe was effected with a large gauze pack and, in addition, soft rubber drains were inserted. The abdominal wound was closed.

The resected right lobe measured 17 cm. in its greatest diameter, weighed 720 gm. and, as stated, was largely replaced by the tumor. Microscopic study of the latter revealed a hemangioma. (Fig. 4.)

The patient was discharged thirteen days after operation.

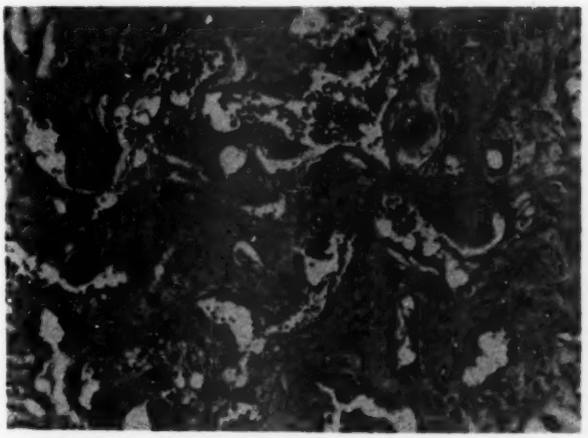

FIG. 4. Case II. Photomicrograph of hemangioma of right lobe of liver showing somewhat more fibrosis than in case shown in Figure 2.

On August 10, 1953, the patient was readmitted because of pain in the right upper quadrant and right back corresponding to the site of the right lobe. After previous discharge to her home in another city, evidence of right subphrenic abscess had developed with chills and fever; this subsequently partially evacuated itself by rupture into the right lung (no operation had been performed) because there were episodes of copious purulent sputum and severe cough. There was temporary improvement but in September, 1952, abdominal drainage was performed elsewhere for persistent subdiaphragmatic abscess. In June, 1953, a fourth laparotomy was performed for exploration, and recurrence of the hemangioma was noted on the inferior margin of the stump of the right lobe.

On August 13, 1953, I performed the fifth laparotomy (Fig. 3B) and exposed a partially regenerated right lobe about one-fourth the size of what the full sized normal right lobe would be expected to be. The recurrence measured about 2.5 by 1 cm. A wedge-shaped segment of liver tissue about 3 cm. in its greatest dimension was resected to include the regenerated lobe. Of special interest was the apparent vascularity of the regenerated right lobe which, although appearing like normal liver tissue, when grasped by the hand could be rapidly and easily compressed as one would compress a sponge.

Histologic study of the excised specimen revealed typical cavernous hemangioma.

The patient was discharged on the ninth postoperative day and has been relatively well

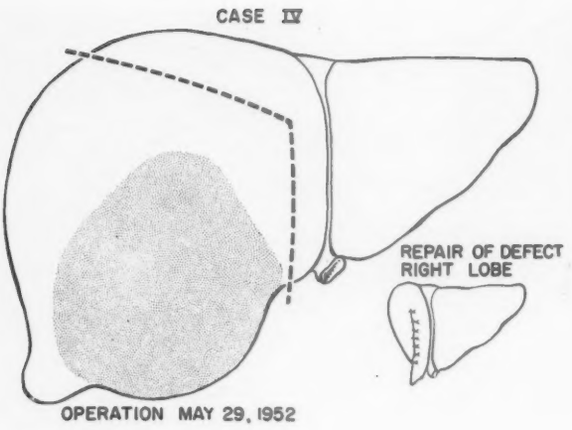

FIG. 5.

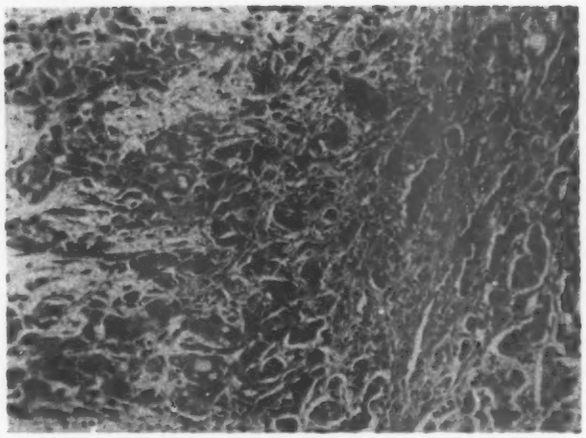

FIG. 6. Case III. Photomicrograph of margin of malignant hepatoma excised from fourteen year old girl (subtotal right hepatic lobectomy). The patient is well five years after operation.

(except for migraine) ever since, five years after right hepatic lobectomy was performed.

On February 15, 1954, two years after the original right hepatic lobectomy, the following blood chemistries were obtained: cephalin flocculation, 4 plus; thymol turbidity, 2.08 units; plasma protein, 8 gm. per cent; prothrombin time, 18.4 seconds; fasting blood sugar, 70 mg. per cent; blood urea nitrogen, 10.4 mg. per cent; serum chloride, 113 mEq./L; CO_2, 22 mEq./L; sodium, 140 mEq./L; potassium, 3.84 mEq./L.

In a recent communication (February, 1957) the patient stated she was reasonably well and fully active.

CASE III. C. T., a fourteen year old girl, was suddenly seized with an acute abdominal pain while playing at school. She was taken to a hospital where a diagnosis of "acute abdomen" was made and laparotomy performed. A large bulging tumor in the right lobe of the liver was noted; apparently it had suddenly ruptured through Glisson's capsule. A biopsy specimen of the small ruptured area was taken and the abdomen was closed. The diagnosis was malignant hepatoma.

Two weeks later, on May 29, 1952, the patient was admitted to my private service, and the abdomen was reopened through a right upper paramedial incision. The large bulging tumor, about 10 cm. in diameter, was observed in the lower anterior portion of the right lobe. The omentum, adherent to the biopsy site, was dissected away. The right lobe of the liver, after being freed from its peripheral attachments, was brought down sharply and outward into the wound. By sharp dissection, the cystic artery and cystic duct below the tumor were exposed and transected, and the gallbladder was removed in the usual manner. By blunt and sharp dissection a large wedge-shaped portion of the right lobe of the liver, including the tumor, was excised, hemostasis being carried out by gauze pressure and by clamping and ligating individual large vessels as they were encountered. (Fig. 5.) At times temporary hemostatic mattress sutures were inserted for compression purposes, 2 to 3 cm. wide of the gross margins of the tumor. At the close of the excision large mattress sutures were inserted through normal parenchyma on each side of the large wedge-shaped excision site and the edges were approximated. It was estimated that about four-fifths of the right lobe of the liver was removed. A gauze pack was applied to the repair site and soft rubber drains placed above and below this area. The abdomen was closed in layers.

The excised specimen measured 12 cm. in its greatest diameter. The included tumor was solid and the fresh surface gray-white in appearance.

The histopathologic diagnosis was reported as showing primary malignant hepatoma. (Fig. 6.)

Convalescence was uneventful and the patient returned to her home in another city. Four years postoperatively she married and has had a normal existence ever since, i.e., five years after operation.

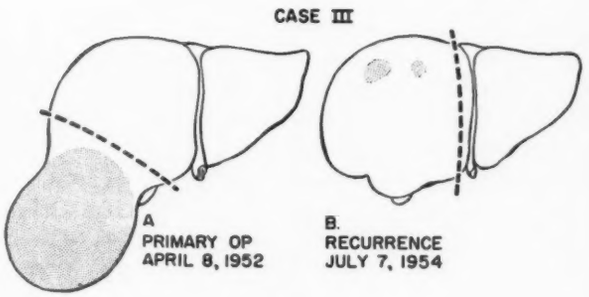

FIG. 7.

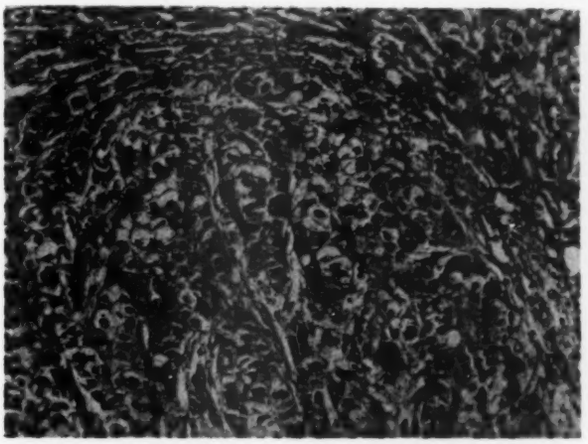

FIG. 8. Case IV. Photomicrograph of malignant hepatoma. The patient is alive and well five years after partial hepatectomy for resection of primary growth and three years after the completion of the right hepatectomy for metastases from the growth confined to the right lobe.

However, there have been two episodes of syncope which occurred since the previously described operation, but thorough clinical and laboratory examinations including encephalogram have been negative.

CASE IV. L. B., a fifty-one year old woman, had undergone excision of a fibroadenoma of the left breast in 1941 and radical mastectomy for carcinoma of the left breast in 1942. On the present admission a large, movable mass was palpable in the right upper quadrant of the abdomen. The patient also had been complaining of menorrhagia and a cervical polyp was present; the uterus was enlarged due to leiomyomas.

On April 3, 1952, the abdomen was opened through a high, midline incision with extension to the right. A fist-sized tumor mass bulging downward from the right lower angle of the right lobe of the liver was observed. Compressing mattress sutures were placed through liver parenchyma well proximal to the margins of the tumor, and by transection through liver tissue the tumor was excised. (Fig. 7A.) As a preliminary step to this procedure, the gallbladder was isolated and removed in the usual manner, more for purposes of exposure of the undersurfaces of the liver rather than from necessity. The incision was then extended downward and radical panhysterectomy for multiple leiomyomas of the uterus was performed.

Pathologic study of the excised neoplasm revealed it to be a malignant hepatoma. (Fig. 8.)

Following the operation the patient had excessive bronchial secretions for which tracheostomy was performed to permit more adequate aspiration of the tracheobronchial tree.

The convalescence was rather stormy, but recovery ensued and the patient was discharged on the twenty-sixth postoperative day. During the months that followed, an incisional hernia developed which fortunately permitted palpation of the remaining four-fifths of the right lobe of the liver.

She was followed up as an outpatient until late spring in 1954 when two separate nodules were palpable on the diaphragmatic surfaces of the right lobe. This was interpreted as metastases to the liver from the previously removed primary malignant hepatoma. On July 1, 1954, the abdomen was entered through the upper portion of the old incision and the hepatic metastases were noted. One measured about 6 cm. in diameter and one measured about 3 cm. in diameter. By means of sharp dissection and repeated series of temporary compressing sutures, the base of the right lobe 2 to 3 cm. to the right of the falciform ligament was transected to complete removal of the right lobe and its included metastases. (Fig. 7B.) Individual vessels were secured and individually ligated. At the close of the operation hemostasis was completed. A gauze pack was applied against the fresh surface and the abdominal wound closed in layers. Pathologic examination revealed that the excised right lobe measured 20 by 16 by 9 cm. The two areas of metastasis measured 6 by 5 by 5 cm. and 3 by 2 by 2 cm., respectively, and were the only areas of metastasis noted. Microscopic study showed these to be "recurrent malignant hepatoma (metastases)." (Fig. 8.)

Convalescence from this procedure, in contrast to the previous convalescence, was essentially uneventful. For several weeks the draining sinuses discharged mucopurulent material, but by November 10, 1954, drainage ceased and the sinuses were healed. During the following months there was enlargement of the left lobe of the liver interpreted as compensatory hypertrophy. Following a maximum of hypertrophy there was regression in size of the left lobe to approximately twice the original size of the left lobe.

Since this time the patient has been seen at frequent intervals and continues to lead a normal existence. Blood chemistries in August, 1956, revealed the following: blood urea nitrogen, 9.2 mg. per cent; plasma chlorides, 111 mEq./L; plasma proteins, 8.7 mg. per cent; alkaline phosphatase, 3.3 units.

COMMENTS

The human organism is quite capable of surviving in normal status with only the left lobe of the liver *in situ*. It has long been appreciated that right hepatic lobectomy has a very large factor of safety; the figure previously given, based on animal experimentation, is 80%. Clinical observations would appear to bear this out for the human being. Detailed laboratory data were not presented in the cases described herein because the survival of the patients over the years in apparently normal status and showing no indication for physiologic disturbances is ample evidence of adequate function of the left lobe in maintaining general physiologic demands.

In a previous report clinical observations of the surgical physiology of the liver, observed incident to partial hepatectomies and hepatic lobectomies, have been discussed [4].

SUMMARY

1. The clinical records of four patients, three of whom underwent total right lobectomies and one of whom underwent subtotal right hepatic lobectomy, are presented.

2. In two instances the lesions were massive angiomas with survival of patients at this writing of six years and five years, three months, respectively. In two instances the lesions were malignant hepatomas. In one instance (Case III), subtotal right hepatic lobectomy was performed when the patient was fourteen years of age. Five years later she married, and is living and well. In the other instance (Case IV), partial right hepatic lobectomy was performed; two years later the right hepatic lobectomy was completed due to metastasis from the primary lesion. The patient is well five years after the first operation and two years, three months after the second operation.

3. The cases reported herein illustrate the principle that not only is right hepatic lobectomy consistently feasible but also prolonged survival in good health following such operations for both benign and malignant disease may be anticipated. The left lobe of the liver alone is adequate to meet all physiologic requirements.

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Operative Cholangiography in Surgery of the Biliary Tract

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IN April, 1952, we reviewed a series of fifty cases in which both choledochostomy and cholangiography had been performed at this hospital during 1950 and 1951 [7]. In that series seventy-nine cholangiograms were taken, of which only 34 per cent were done in the operating room. The remainder were taken postoperatively. Of the fifty patients, 18 per cent retained stones in the common duct. Therefore, we made certain recommendations to help reduce this percentage, one of the most important of which was the more frequent use of operative cholangiography. Since that time this procedure has been much more frequently used and at present is almost routine.

In this paper we are reviewing 100 consecutive cases treated during 1955, in each of which exploration of the common duct and operative as well as postoperative cholangiograms have been taken. The purpose of this review is to see if we have improved our surgical care of these patients in the last few years, and to see if operative cholangiography has helped in reducing the percentage of retained common duct stones.

OBSERVATIONS

Sex Incidence. In this series there were seventy-two females and twenty-eight males. This corresponds with many other reports, showing that cholecystitis and cholelithiasis are almost three times as common in females as in males.

Morbidity and Mortality. At one time the single added procedure of common duct exploration along with cholecystectomy definitely increased the morbidity and mortality rates of these patients. In 1932 Lahey reported that in his clinic simple cholecystectomy had a mortality rate of 4 per cent. This rose to 13 per cent when choledochostomy was added. However, over the years this percentage has dropped throughout the country. A review of biliary surgery done during 1954 at the Mayo Clinic showed a 0.52 per cent mortality rate from cholecystectomy alone as compared to 1.2 per cent in cases in which the common duct was also explored [12]. Mixter [22] reports a rise in the mortality rate of from 0.7 per cent for cholecystectomy alone to 3.9 per cent when choledochostomy was added. Does another added procedure, that of operative cholangiography, increase the morbidity or mortality rates? In our series of patients reported in 1952 there was no mortality in the 34 per cent who underwent operative cholangiography. In this series of 100 patients, all of whom had operative cholangiograms taken, there was no mortality. In reviewing the literature we find very little mention of mortality or morbidity, even in the very large series of cases such as that of Hicken [13] and others, showing that the belief of most surgeons is that the procedure is harmless. Baker [1], in his editorial on operative cholangiography, just barely mentions the possibility of untoward sequelae such as reflux pancreatitis and chemical cholangitis. We have not observed this in our patients and have not seen it mentioned elsewhere in the literature. In our own patients, any increase in morbidity was believed to be due not to operative cholangiography but to exploration of the common duct and the suture of a T-tube in it, or to the added duodenotomy and division of the sphincter, and the complications that might come from those mechanical procedures.

If we use the length of postoperative stay in the hospital as one indication of morbidity, we find that 55 per cent of the patients stayed

from nine to twelve days, 73 per cent stayed from nine to fourteen days, and 14 per cent stayed twenty days or more. This latter percentage is made up chiefly of those who had retained stones and were hospitalized longer while the Pribram treatment was tried or re-

TABLE 1
INDICATIONS FOR EXPLORING THE COMMON DUCT

Indications	No. and Per cent of Cases	Stones in Common Duct	
		No. of Cases	Per cent per Indication
Dilatation of common duct	50	20	40
Jaundice, or a history of it	28	14	50
Stone shown by pre-choledochostomy cholangiogram	9	8	89
Small stones in gallbladder	8	0	0
Stones palpated in common duct	5	5	100

operation was performed. The average postoperative stay in our series was 13.6 days. This may be compared with a postoperative stay of 14.6 days in a series of 550 biliary operations reported by Flannery [8], in which only 7 per cent underwent exploration of the common duct. We definitely believe that operative cholangiography has not increased the morbidity in our series of cases.

Types of Surgery Performed. In this series ninety-four patients underwent cholecystectomy and exploration of the common duct. Three of these patients had cholecystostomies two to five months before. Six patients had undergone cholecystectomy two to twenty years previously and in these cases only exploration of the common duct could be performed. In four of the 100 patients, duodenostomy and sphincterotomy had to be performed along with the other surgery.

Incidence of Stone in the Common Duct and Gallbladder. In the entire 100 patients in this series, stones were found in the common duct in 47 per cent. (Table 1.) This figure can be compared with that of Baker [1] who found stones in 50 per cent of the cases in which the common duct was entered, and those of Hallenbeck [12] who found stones in 38.6 per cent of the cases in which the common duct was opened. Singleton [27], in May, 1956, reported a series of 125 patients who underwent exploration of the common duct. Stones were found in forty-three (34.4 per cent). Of the ninety-four patients of our series who underwent cholecystectomy and choledochostomy, forty-one (43.6 per cent) had stones in the common duct. All six patients in whom only choledochostomy could be performed, because the gallbladder had been removed two to twenty years before, had stones in the common duct. It is interesting to note that four of these patients had to undergo reoperation because of jaundice and two because of biliary colic.

Of the ninety-four patients who underwent cholecystectomy, eighty-eight (93.6 per cent) had stones in the gallbladder. In three of these patients cholecystostomy had been performed two to five months before, and no stones were found in the gallbladder or in the common duct which was explored because of thickening or inflammation.

INDICATIONS FOR EXPLORING COMMON DUCT

The indications shown in Table 1 are the typical ones described in many reports and textbooks. There is one interesting factor to be noted, however: the number of patients explored for simple dilatation of the common duct is 50 per cent, while the patients explored because of jaundice or a history of it (and all of them were) is only 28 per cent. This seems to indicate that the surgeons of this hospital no longer wait for jaundice as the prime reason for exploring the common duct. This is fortunate since 27 per cent of our patients had stones in the common duct without jaundice. Exploration was performed and the stones were found only because the common duct was dilated. This question of dilatation of the common duct as an indication for its exploration was discussed recently by Baker [1]. He reported that in seventy-six patients with stones in the common duct and in twelve with fibrosis of the sphincter, all were dilated except four. In other words, 95 per cent of these patients had dilatation of the common duct. He stated, therefore, that in his belief, dilatation of the common duct should be the chief indication for exploration or operative cholangiography. Sin-

gleton [27], on the other hand, reports 125 cases in which the common duct was explored manually. The indication for exploration was jaundice in 116 cases and a dilated common duct in only six cases.

There is no question that dilatation of the common duct is very important and that all such cases should be explored. However, the percentage column in Table 1 shows that while the common duct was opened more times for dilatation than for any other reason, the percentage of cases in which stones were found was lowest (40 per cent). A comparison of this percentage with the twenty-eight cases in which the common duct was opened for jaundice reveals that in the latter cases 50 per cent showed stones. Likewise, in those patients surgically explored because stones were seen in the common duct in a precholedochostomy cholangiogram, 89 per cent showed stones. In other words, in our series dilatation was by far the most frequent indication for opening the common duct, but was the least rewarding in discovering stones in the common duct.

Jaundice. Jaundice, of course, is one of the positive indications for exploring the common duct. In this series the common duct was explored because of jaundice in 28 per cent of the patients.

In 68 per cent of these cases the jaundice was due to stones in the common duct. In 20 per cent the cause of the jaundice was undetermined. Since all of these patients left the hospital with normal postoperative cholangiograms it must be assumed that the jaundice was due to some temporary inflammatory lesion about the lower end of the common duct or about the papilla of Vater. In 9 per cent pancreatitis was the cause of jaundice, and in 3 per cent it was caused by an obstructive tumor at the lower end of the common duct.

It has been shown in numerous reports that stones in the common duct do not always cause jaundice. We found in this series that 27 per cent of the patients had stones in the common duct without jaundice. Other series such as Theissen's [28] show that as many as 65 per cent of the patients had stones in the common duct without jaundice. Hicken [13] recently reported a group of 110 cases of retained stones in the common duct and in these cases jaundice had developed in only 21 per cent since the first operation. This means that 79 per cent had stones in the common duct without jaundice. Of course there is no way of determining when these stones will become active, move down the duct, become impacted and cause jaundice. Each stone in the common duct has such a potential and it is for this reason that once the common duct has been opened and stones found, every possible method must be used to make certain that all the stones are removed.

Cholangiograms. There were 231 cholangiograms taken in this series. They were of two main types: the operative cholangiogram which, as the name implies, was taken during surgery in the operating room; and the postoperative cholangiogram which was taken seven to nine days later in the x-ray department. There is no question about the accuracy and the routine use of postoperative cholangiography. On the other hand, there has been a great deal of discussion throughout the country as to the value of operative cholangiography. The opinions are by no means alike. Clark [6], in 1954, reported on the opinions of many hospitals and doctors concerning the use of operative cholangiography. He showed that 102 hospitals used it while thirty-four did not; that seventy-eight surgeons used it and thirty-nine did not, and that twenty-eight radiologists used it and nineteen did not. In obtaining an estimate of the value of operative cholangiography he reported that sixty-eight surgeons stated it was excellent, four stated it was good, and thirty-nine believed it was fair to worthless. It is interesting to note the conflict of opinions. Hoerr [15], in Cleveland, believed that modern gallbladder surgery was incomplete without cholangiography. Partington, in his discussion of Hoerr's paper, said that the most important factor about cholangiography is its routine use. Tedrich of Iowa City believed its routine adoption in common duct surgery was necessary. Hicken [13], who has had great experience with cholangiography, stated in May, 1954, that "cholangiography is transforming surgery of the biliary tract from a haphazard procedure to an exact science." On the other hand, Welch [31] of Boston stated that "at the present moment not much enthusiasm has been engendered except in cases that are re-explored for recurrent or persistent stones." Johnston and Waugh [18] of the Mayo Clinic thought that the low rate (8 per cent) of retained stones in 153 cases of choledocholithotomy compared very favorably with comparable statistics reported by surgeons who use surgical cholan-

giography. "In our opinion the method must become more accurate before it can replace surgical exploration of the ducts by experienced surgeons, or become a routine part of choledocholithotomy." About the same time (April, 1955) Walters [30] stated that, "since 1946, only four cases are recalled in which a common or hepatic duct stone was overlooked at exploratory choledochostomy." This was without benefit of operative cholangiography. He believed that thorough and complete exploration of the common duct was better than operative cholangiography in view of the high percentage of unsatisfactory or inaccurate results reported by various men using it.

The aforementioned opinions were gathered in 1954 and 1955. In April, 1955, Preston [25], because of the poor results (24.3 per cent retained stones obtained by standard methods), abandoned all cholangiography and made a strong plea for treatment of obstruction of the lower third of the common duct by transduodenal ampulloduodenostomy. He divided the sphincter of Oddi and the ampulla of Vater and explored the common duct from below, and then established a large ampulloduodenostomy for biliary drainage. The opening is large enough, it was stated, to allow any stones coming down from the hepatic radicles, or left in the common duct by error, to pass through into the duodenum, rather than block the common duct. He did not perform operative cholangiography and, since he did not use T-tubes, no postoperative cholangiograms were taken. He reported thirty-eight cases (one of eighteen months' duration was the longest) without duodenal fistula or jaundice. In contrast to this report, Baker [1] advised postcholedochostomy and postoperative cholangiography in all cases in which the common duct was explored.

All this difference of opinion makes it obvious that operative cholangiography is not 100 per cent satisfactory, and this has been so stated in many reports. However, the consensus from the literature is that it is also definitely helpful. Many reports have in their concluding paragraphs perhaps not the same words but certainly the same thoughts, namely, that operative cholangiography is no substitute for surgical judgement as to when to open the common duct, or for surgical skill in the treatment of stones in the common duct, but it is a very valuable supplement. We concur in this opinion after reviewing our 100 cases.

OPERATIVE CHOLANGIOGRAPHY

As has been mentioned previously, operative and postoperative cholangiograms were taken in all 100 patients. The operative cholangiograms may be divided into two types: those done before exploration of the common duct (the precholedochostomy cholangiograms) and those done afterward (the postcholedochostomy cholangiograms).

The precholedochostomy cholangiogram is taken by making a small transverse incision in the cystic duct and pushing a ureteral catheter through it about 2 to 3 cm. into the common duct and then injecting the dye. Thirty cholangiograms were taken in twenty-eight cases. Of these, seventeen (56 per cent) were normal and nine (30 per cent) were diagnosed as showing stones. All of the nine patients diagnosed as having stones in the common duct were explored. Eight of the nine showed stones, one showed none. This gives us an 11.1 per cent false positive report. A postcholedochostomy film was taken in six of these nine patients. It is interesting to note that of the three not taken, the postoperative film showed retained stones in two cases. The percentage of false negative reports was 11.7; the percentage of unsatisfactory films was 14.4.

The postcholedochostomy cholangiogram (Fig. 1) is taken through a T-tube in the common duct after it has been explored but before the abdominal cavity is closed.

Eighty-one postcholedochostomy cholangiograms were taken in seventy-two patients. Of these, fifty-one (62.9 per cent) were normal. In twelve cases (14.8 per cent) no stones were seen in the common duct, but no dye entered the duodenum. These cases were due probably to spasm of the sphincter of Oddi. In Kantor's [19] series, of 158 operative cholangiograms taken, 22.2 per cent showed spasm. This spasm occurs much more frequently in operating room cholangiograms than in postoperative cholangiograms. This may be due to the morphine so frequently used as a preoperative medication. In postoperative cholangiograms it is common to see the first 1 or 2 cc. of the dye run into the duodenum, even before the common duct is filled up. Kantor stated that spasm in the operating room cholangiogram was three times that in the postoperative film. In eleven cases (13.6 per cent) the films were questionable, that is to say, stone could not be ruled out and

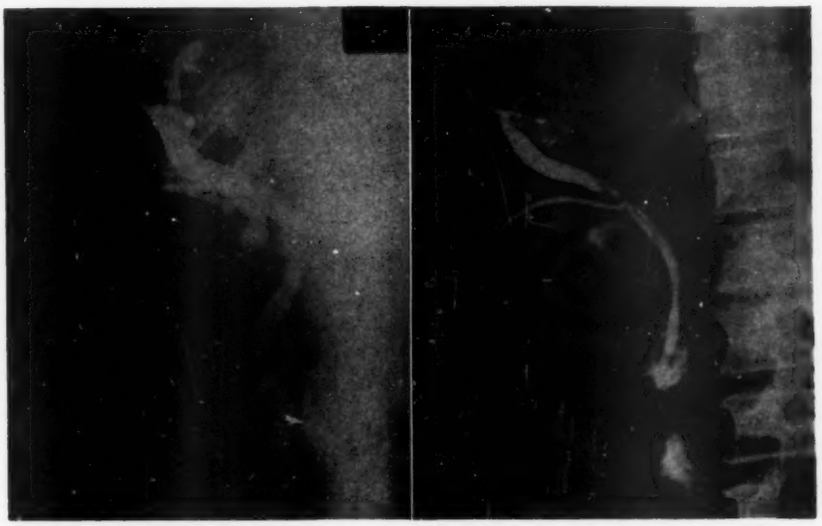

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FIG. 1. A, the common duct was explored because of dilatation. One stone was removed and common duct thought to be cleared. Postcholedochostomy film shows one stone still present at lower end of common duct. Common duct reopened and stone removed. B, postoperative film shows common duct to be clear. Rounded calcified mass has been present for years and is not connected with the biliary system.

yet the film could not be called normal. It is significant that in three of these cases in which the report was questionable, stones were found in the postoperative films. In two cases (2.5 per cent) the films were definitely unsatisfactory. Neither of these showed stones in the postoperative cholangiogram. In one case (1.2 per cent) hepatic stones were seen and in this case, as in another, they could not be reached and had to remain. In three of seventy-two cases a false negative report was given (4.1 per cent).

In four cases (5 per cent) stones were diagnosed in the common duct. In each of these cases the common duct was reopened and the stones removed. In one case, because the stone was impacted, duodenostomy and sphincterotomy had to be performed before the stone could be removed. In all four cases postoperative films were negative. This is perhaps the greatest value of the postcholedochostomy cholangiogram. (Table II.) Without it, in this series at least, there would have been a 5 per cent increase in retention of stones in the common duct. In a private communication, Wall [29] of St. Louis reported that operative cholangiograms were directly responsible for detecting stones which were missed on exploration of the common duct in 9 per cent of his cases. Hughes [17] of England reported that they were similarly responsible in 10 per cent of his cases, and Mixter of Boston reported the same in 13 per cent of his cases. The reduction of the retention of stones in the common duct by 5 to 13 per cent is indeed a contribution to good surgery.

TABLE II

PERCENTAGE OF STONES FOUND IN COMMON DUCT BY POSTCHOLEDOCHOSTOMY FILM AFTER EXPLORATION OF COMMON DUCT

Author	Per cent
Corff	5
Wall	9
Hughes	10
Mixter	13

POSTOPERATIVE CHOLANGIOGRAMS

Postoperative cholangiography was routine in all cases in this series. This is done from seven to ten days after operation. There were 120 taken in the series of 100 patients. Of these, 103 were normal, ten showed stones in the common duct, four were questionable, two showed possible obstruction in the hepatic radicles, and one was unsatisfactory. Of the four questionable cases, two were due to air bubbles, one was due to the use of a catheter in the common duct instead of the T-tube, and

one was due to extravasation of dye which hid some of the details. The one unsatisfactory case was due to the fact that the T-tube was entirely blocked and no dye could be gotten into the duct. The T-tube was removed before another attempt at cholangiography could be made. If we place the questionable and the unsatisfactory results in one category, the outcome would be five of 120 sets of film (4.1 per cent). This is low compared to the surprisingly high percentage that Kantor reported. In his series, 32.4 per cent of the postoperative films were not satisfactory. It is believed that our low percentage of questionable or unsatisfactory results in the postoperative patients was due in great part to the improvement of our technical equipment by Boreadis [3] of this hospital. He devised equipment by which excellent upright cholangiograms could be taken, thus eliminating in great measure the air bubbles which can so easily be mistaken for stones, giving questionable results.

TABLE III
PERCENTAGE OF STONES RETAINED IN COMMON DUCT WITHOUT OPERATIVE CHOLANGIOGRAPHY

Author, Location and Year Reported	Per cent
McKittrick, Boston, 1949	2.0
Buxton, U. of Michigan, 1948	5.9
Waugh, Mayo Clinic, 1954	8.0
Hicken, Salt Lake City, 1954	20.0
Preston, Wilmington, Del., 1955	23.4
Hughes, Cleveland Clinic, 1948	24.0

RETAINED STONES IN THE COMMON DUCT

This is a problem common to the best surgeons and clinics in this country and abroad. (Table III.) Some surgeons, such as McKittrick [*21*] in 1949, have reported an incidence of retained stones as low as 2 per cent without the use of operative cholangiography. Waugh [*18*], in 1954, reported 8 per cent retained stones. Walters [*30*], in 1955, stated that since 1946 he had observed only four cases in which stones were retained in the common duct after exploratory choledochostomy. On the other hand, in 1954 Hicken and his associates [*13*] reported a series of 550 patients treated in small rural hospitals, charity hospitals and teaching centers by junior staff men, house officers and experienced surgeons in which there was a 20 per cent incidence of retention of stones. They stated that Farris of Los Angeles had made a similar study with similar findings (22 per cent retention of stones). In 1955 Preston and Alden [*24*] reported as high as 24.3 per cent retention of stones. In none of these reports was operative cholangiography used. The question arises as to whether or not operative cholangiography has reduced the incidence of retained stones. There are few comparative series in the literature. (Table IV.) Paine and Firme [*23*] in 1954 reported a 25 per cent retention of stones in a nine-year period from 1944 to 1953. In 1945 it was 28 per cent; in 1953 it was 22 per cent. In 1945 operative cholangiography was used in 6 per cent of explorations of the common duct, and in 1953 it was used in 58 per cent. It is difficult to say that the drop of 6 per cent was due to the more frequent use of operative cholangiography. In our own series of cases reported in 1952, in which only 34 per cent had operative cholangiography, there was retention of stones in 18 per cent. In this present series of 100 cases all had operative cholangiography and there was a 10 per cent retention of stones. We cannot say, of course, that this reduction of 8 per cent is due entirely to the use of operative cholangiography. We can say, however, that were it not for postcholedochostomy cholangiography there would have been at least 15 per cent retention instead of 10 per cent. In other words, in our series operative cholangiography was directly responsible for detecting stones which were missed on exploration of the common duct in 5 per cent of the cases. Wall [*29*] stated that in 9 per cent of his cases stones were similarly detected after exploration of the

TABLE IV
RETENTION OF STONES IN COMMON DUCT WITH USE OF OPERATIVE CHOLANGIOGRAPHY

Author and Year of Study	Per cent of Operative Cholangiograms	Per cent of Retained Stones	
Paine and Firme—1944	6	28	6% reduction
1953	58	22	
Corff, Berger and Cohen—1951–1952	34	18	8% reduction
Corff—1955	100	10	

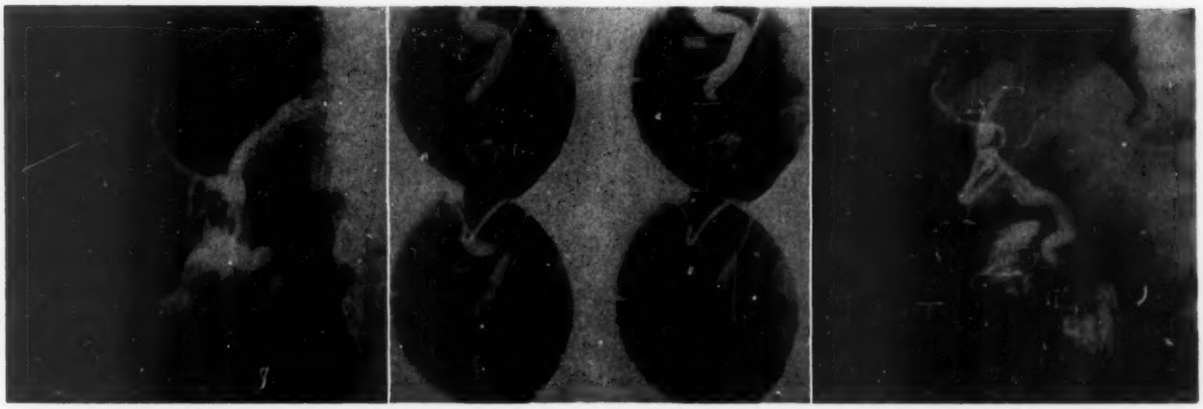

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FIG. 2. A, precholedochostomy film shows a circumscribed radiolucency in the distal common duct, with impaired flow of dye. It was thought to be an air bubble since additional films did not show it. The common duct was explored because of the questionable diagnosis; nothing was found. B, postoperative film shows two stones in the common duct. C, stones in the gallbladder were tested and found to be very soluble in ether-alcohol solution and this was used to irrigate the common duct. Two days later another postoperative film showed the stones gone and dye flowing easily into the duodenum.

common duct; Hughes [17] reports detection in 10 per cent; and Mixter [23] reports an even higher incidence, 13 per cent, in his cases in which stones might have been missed had it not been for the operative cholangiograms taken just before the abdomen was closed.

Of the ten patients in our series with retained stones, two were reoperated within two weeks of their original operation. The stones were successfully removed and the postoperative cholangiograms were normal. Two patients were cleared of their stones by the Pribram method before leaving the hospital (Fig. 2); one in two days, and the other in two weeks. The other six were sent home with the T-tube in place for biliary flushes at home or were told to return at a later date for reoperation.

Why did these ten patients have retained stones even after operative cholangiograms were taken? In three cases the postcholedochostomy film was reported as negative and, therefore, no further action was taken. In two cases the precholedochostomy film showed stones; the common duct was opened and explored and the stones were removed, but no postcholedochostomy films were taken. Had they been taken we would have perhaps had two less cases of retained stones. In three cases the reports on the operating room films were questionable. In these cases the surgeon, believing the exploration of the common duct was adequate, decided that re-exploration was not necessary. In two cases the postcholedochostomy films showed hepatic stones which could not be reached, and a clear common duct. By the time the postoperative film was made the stones had dropped down into the common duct and the hepatic ducts were clear.

It is interesting to note that of these ten cases, two had twenty-five or more stones in the common duct at the time of exploration. It is believed that in any case with that many stones it will be very difficult to ascertain that all stones are removed. Certainly there is a greater chance of retention of stones in these cases than in those in which only a few stones are found.

Although a 10 per cent incidence of retained stones in the common duct is not high, as compared with the reports throughout the country of 20 to 24 per cent, we believe that it should have been less.

Briefly, of the ten cases of retained stone, three were definitely due to false negative reports, three were due in part to questionable reports, and two were possibly due to the fact that no postcholedochostomy films were taken. In other words, under ideal conditions the retention of stones might have been reduced to the 2 per cent due to stones in the hepatic radicles which dropped down into the common duct.

COMMENTS

Operative cholangiography is of great use to the majority of surgeons. It will not, however, entirely eliminate retained stones in the common duct because of several factors which are

beyond the control of the surgeon. One factor is that of the intrahepatic stone which cannot be reached at the time of surgery but which drops down into the common duct in the first seven to ten days postoperatively and is noted in the postoperative film. Another factor is that operative cholangiography is not yet 100 per cent perfect. There is a certain percentage of unsatisfactory and/or questionable films taken, as well as a certain percentage of false positive and false negative reports. As long as such is the case there will be retained stones. Recently a new and improved portable x-ray machine was put into use in the operating room of our hospital. Because of its higher penetrating power and shorter exposure time the cholangiograms are now clearer, and I am certain that the next series will show much fewer unsatisfactory or questionable films, resulting in a smaller percentage of retained stones.

Of the two types of operating room films, each has its own special value. The precholedochostomy film, if it were 100 per cent perfect, would be the procedure of choice since it would definitely avoid opening many common ducts and thus save much time and needless effort. Unfortunately, in our series there have been 11 per cent false positive reports and 11.7 per cent false negative reports. The postcholedochostomy film, which should be taken whenever the common duct has been explored, is perhaps the more valuable of the two types. This is because it is really a check film taken after exploration of the common duct but before the incision is closed. It has proved itself in 5 per cent of the cases in our series, and up to 13 per cent in other series, by picking up stones left in the common duct after it has been explored. In these cases the duct was reopened and the stones removed, thus dropping the percentage of retained stones.

Skill achieved from long experience in exploring common ducts is still the most important factor in reducing the incidence of retained common duct stones. Hicken et al. [13] reviewed 550 cases in which biliary surgery was performed and analyzed 110 cases of this group (20 per cent) in which common duct stones had been retained. They reported that retained stones were ten times as common in the hands of the young and inexperienced surgeons as in the hands of the older and more experienced ones. These inexperienced men were able to handle the simple cases, but they did not have the skill, achieved only from managing the difficult and complicated cases, to take proper care of those cases which were difficult due to unexpected ductal and/or vascular anomalies, hemorrhages or the disguised anatomy present in highly inflamed cases. McKittrick [21] of Boston, on the other hand, reported only 2 per cent retained stones without operative cholangiography in 1949. In 1954 Waugh of the Mayo Clinic reported 8 per cent retained stones without operative cholangiograms, and in April, 1955, Walters stated that in eight years he had treated only four cases of retained stones. He did not give the number of patients he had seen but I am certain that the percentage of retained stones must have been very small indeed. He believed that thorough exploration of the common duct was more accurate than operative cholangiography. Welch [31] of Boston concurs with the previous writers. He reported that in his last 100 consecutive cases in which the common duct was explored there was possibly one case of retained stones. He did not use operative cholangiography in any of these cases. He stresses the point of dilating the sphincter of Oddi in every case in which the common duct is explored, and that it should be dilated to 1 mm. less than the diameter of the common duct. This will allow any stone possibly left in the duct to pass out of it without difficulty. He likewise believes that measuring the size of the hepatic ducts with the dilators and then dilating the sphincter to a wider diameter probably should allow stones from the hepatic duct to pass through. He, like Waugh and Walters, believes that his ability to explore and remove stones is more accurate than operative cholangiography. He thinks the latter is important only in secondary surgery of the biliary tract.

After examination into our own series of cases we certainly believe that in the hands of the residents and surgeons in our own hospital, operative cholangiography, especially the postcholedochostomy type, is of great value and should be used in every case in which exploration of the common duct is performed. From a review of the literature throughout the country, with reports of up to 25 per cent retained stones without operative cholangiography, there is no question that it should be used generally, especially the postcholedochostomy type, since this has reduced the incidence of retained stones 5 to 13 per cent in

different series of cases. The greatly experienced surgeons who have reported an incidence of 1 to 8 per cent retained stones without operative cholangiography, since their results are better than the average even with operative cholangiography, certainly need it less than most surgeons. On the other hand, if they seek perfection, the postcholedochostomy film may still pick up the occasional stone which even they may leave in.

SUMMARY

1. We have reviewed 100 cases, in each of which exploration of the common duct, operative cholangiography and postoperative cholangiography were performed.

2. There was no mortality in this series.

3. There was little or no morbidity due to the procedure of operative cholangiography itself.

4. The indications for exploring the common duct are given. Dilatation of the common duct was the most frequent indication (50 per cent). Jaundice was the next most frequent (28 per cent).

5. Stones in the common duct were found in 47 per cent of our cases and in 50 per cent of the jaundiced cases. It is interesting to note that 27 per cent of our patients had stones in the common duct without jaundice.

6. The results of 111 operative cholangiograms and 120 postoperative cholangiograms are discussed. Thirty precholedochostomy films and eighty-one postcholedochostomy films were taken. In the precholedochostomy films in which stones were diagnosed, 11 per cent were false positives. In the cases diagnosed as not having stones, 11.7 per cent were false negatives. This type of cholangiography must be made more accurate before it becomes of real value.

The postcholedochostomy cholangiogram has proved to be more valuable in that in the eighty-one taken in our series, it picked up stones left in the common duct after exploration in 5 per cent of the cases. In these cases the common duct was reopened and the stones removed before the incision was closed. This is perhaps the greatest value of operative cholangiography.

7. One or more postoperative cholangiograms were taken in all of our 100 cases. In 10 per cent of the cases retained stones were found in the common duct. An analysis of these cases is given; under ideal circumstances the incidence of retained stones might have been reduced to 2 per cent.

8. There is no question that in the hands of most surgeons operative cholangiography is of great help in surgery of the biliary tract. However, it cannot and should not replace surgical skill, experience and judgment in the treatment of stones in the common duct.

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Facial and Neurocranial Growth after Removal of the Mandibular Condyle in the Macaca Rhesus Monkey

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AN understanding of normal and abnormal growth forms the basis for early recognition and proper treatment of some deformities of the face. The problem of plastic surgical treatment for underdevelopment of the face is a difficult one. The dysplastic pattern of growth continues. In unilateral disturbances the discrepancy between the two sides of the face becomes greater as the patient becomes older because of lack of growth of the affected side. Even though the deformity may not be progressive, it is not self-correcting and there is no way to compensate for the lost or retarded growth. The disturbance itself is not corrected by orthodontic, prosthetic or surgical procedures. However, these measures do give functional and cosmetic improvement. Consequently, the plastic surgeon is called upon to treat and improve the appearance of these abnormalities. Usually the surgical procedures are directed toward contributing bulk and increasing length by means of bone, cartilage and soft tissue grafts as well as flaps. Cartilage has been transplanted as a masking procedure to build up the flat side in asymmetries when one condyle has been affected, or to the mental area when there has been a symmetric arrest. Attempts have been made to alter the position of the mandible by various types of osteotomies. It must be remembered that when these corrections are made in the patient who has not attained full growth, a later correction will be necessary in adult life. It might be feasible to consider, in the otherwise normal child, transplantation of a rib cartilage-bone graft with an actively growing costochondral junction as a replacement of the lost condylar growth site [*11*].

Facial growth is a result of an integration of activities in a number of regions. Mandibular growth is an important part of facial growth. Two types of mandibular bone growth occur in the following principal areas: (1) appositional—at the posterior border of the ramus, the sigmoid notch, the coronoid tip, the alveolar margin adjacent to the teeth, and less so at the inferior and anterior borders; and (2) epiphyseal-like growth—at the condyle. Concurrently there is continuous surface remodeling, particularly at the anterior border of the ramus and the medial border of the mandible. Normal development of the mandible is dependent upon the synchronous co-ordination of the growth activities of the various centers. Any interference which will affect these growth centers will alter the orderly progression of development and will result in some type of mandibular deformity.

Growth of the condyle is by endochondral ossification. Microscopic examination reveals the presence of three zones: (1) chondrogenic, (2) cartilaginous and (3) osseous. (Figs. 4A and 4B). The condyle is capped by a narrow layer of avascular fibrous tissue which contains connective tissue cells and a few cartilage cells. The inner layer of this covering is chondrogenic, giving rise to hyaline cartilage cells which constitute the second zone. In the third zone destruction of the cartilage and ossification around the cartilage scaffolding can be seen. The cartilage in the head of the mandible,

FIG. 1. Postmortem anterior view of formalin-fixed monkey head number 7 resting on the lower border of the mandible. The right mandibular condyle was removed at approximately eight months of age, with a postoperative survival period of four months. Note the asymmetry, lesser development in height and width of the right side of the face, and in this position the lower level of the right external ear. The right side of the face appears to be fuller than the flatter, longer left side. Also, observe the face when the transcanthal line is in the horizontal plane.

however, is not homologous to an epiphyseal cartilage because it is not interposed between two bony parts. It must also be remembered that it is not homologous to an articular cartilage because the free surface bounding the articular space is covered by fibrous tissue.

The condyle serves as the pacemaker and organizer of mandibular growth and is, therefore, the most important growth center of the mandible [*1*]. Much has been learned from the clinical studies of patients with either congenitally deficient condyles or those affected by inflammation or trauma [*2,3*]. The effects that the aforementioned causes will have upon the growing condyle and subsequent deformity of the jaw are determined not only by the severity and duration of the noxious agent but also by the particular time of occurrence. Thus, the effect will be more marked early in life when condylar growth activity is greater than later in life when condylar growth activity is markedly decreased and the mandible has nearly assumed its adult form and size.

In a previous report [*4*] the effects of removal of the condyle on mandibular growth were described in a group of young monkeys, with a postoperative survival period ranging from four to seventeen months. (Table 1, Figs. 1, 2 and 5–7.) Little reference was made to the alterations in total facial and neurocranial growth. The purpose of this report is to demonstrate,

TABLE 1

MANDIBULAR FINDINGS IN GROWING MONKEYS WITH BILATERAL OR UNILATERAL CONDYLECTOMY AND A POSTOPERATIVE SURVIVAL OF FOUR TO SEVENTEEN MONTHS, AS COMPARED WITH UNOPERATED MONKEYS

I. Postoperative observations
  A. Able to take standard diet
  B. No difficulty opening mouth
  C. No ankylosis
  D. Open bite (bilateral condylectomy)
  E. Shift of mandible toward operated side (unilateral condylectomy)
II. Postmortem observations
  A. Gross (Fig. 1)
    1. Region of temporomandibular joint (Figs. 6 and 7)
      a. Functional false joint anterior to glenoid fossa
      b. Articulating surfaces greater and irregular
      c. False condyle with medial thickening
      d. Articular eminence less prominent or absent
      e. Glenoid fossa shallower
      f. Postglenoid process shorter
    2. Mandibular ramus (Fig. 6)
      a. No true sigmoid notch
      b. Coronoid process highest part of mandible, above level of zygomatic arch and heavier
      c. Ramus shorter
    3. Mandibular body (Figs. 5 and 6)
      a. Mandibular angle less
      b. Height of body less
      c. Antegonial notch accentuated
      d. Open bite in incisor region (bilateral condylectomy)
      e. Shift of midpoint of mandible to operated side (unilateral condylectomy)
  B. Roentgenographic findings (Fig. 2)
    1. Ramus more radiolucent
    2. Trabecular pattern of bone reoriented and converged toward new articular area
    3. Suggestion of impaction of unerupted last mandibular molar

by gross and roentgenographic studies in a similar group of monkeys with a longer postoperative survival period (twenty-five to thirty-five months), that removal of the condylar growth site of the mandible will markedly influence not only growth of the mandible but also that of the face and neurocranium. No such report has been found in the literature.

Although the anatomic details were not

identical with that of the human being, it was believed that important information would be obtained in regard to abnormal and normal growth of the skull. We detect disease by observing alterations from the normal. However, it is less well appreciated that, conversely, the findings in the abnormal may be employed to test and extend our knowledge of the normal.

MATERIAL AND METHODS

The animals used in these experiments were Macaca rhesus monkeys obtained from Frank Buck in Florida and the Chase Wild Animal Farms, Egypt, Massachusetts. Because the growth activity of the mandibular condyle is greatest during early life, the youngest monkeys obtainable were ordered. The age when the monkeys were received was estimated according to the dentition to be approximately eight months. They weighed from 2 to 2.5 kg. The monkeys in this experiment included unoperated controls, animals in which the right mandibular condyle was resected, and animals in which both mandibular condyles were resected either partly or completely. In addition, for purposes of comparison, certain skulls were selected from the group previously reported [4].

The monkeys were anesthetized by means of an intraperitoneal injection of a 3 per cent aqueous solution of sodium pentobarbital (1 cc./kg. of body weight), in order to perform the surgical procedures. The skin surrounding the region of the condyle was shaved. By means of a sterile surgical technic, the skin and subcutaneous tissue were incised anterior to the tragus of the ear for a distance of about 1 cm. The parotid fascia and gland were reflected. The capsule of the temporomandibular joint was opened and the mandibular condyle was exposed. Because of the width of the condyle and the short neck, it was found that the condyle, including part of the neck, could be resected more readily by means of a tapered fissure dental bur. The disk was usually not removed. Hemorrhage was controlled. The deep tissues were sutured with No. 000 plain catgut and the skin closed with No. 000 black silk. No attempt was made to fill the space created by removing the condyle with muscle, fascia or other tissue. The mandible was not fixed to the maxilla in any way. Thus, the animal was permitted free use of the jaws at all times. The postoperative survival period ranged from twenty-five to thirty-five months. An attempt was made to obtain comparable unoperated controls. This, however, was not entirely feasible because the exact age of the animals was not known.

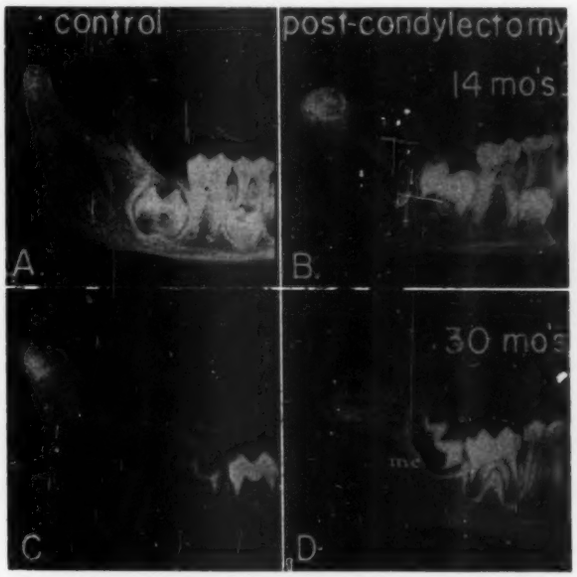

FIG. 2. Postmortem lateral roentgenograms of left side of disarticulated dissected mandibles of four growing monkeys. A, animal number G-1 with intact mandibular condyle. B, animal number 11. Both condyles were resected fourteen months before death. C and D, older animals of approximately comparable age. C, animal number 4. Left mandibular condyle intact. D, animal number 10. Left condyle resected thirty months before death. The last molar crown is unerupted, impacted and relatively high in the ramus. Examination of roentgenograms of the maxillary last molar did not reveal it to be malposed. Compare change in direction of posterior part of mandibular canal (mc) and its proximity to the new articular area. Compare the pattern of the trabeculae and the relative radiodensity. In the operated animals the trabecular pattern is reoriented in relation to the new articular area. Compare the configurations of the rami and the coronoid and condyloid processes noting height, width, direction and irregularity. Also, note the comparable but more marked changes in (D) than in (B).

Upon the death of the animal, the head was severed and fixed in a 10 per cent solution of formalin. The skulls and mandibles were cleaned by dissection and boiling in a solution of sodium hydroxide. Photographs and roentgenograms of the mandibles and the skulls were taken. The tops of the skulls were sawed off. One animal in which the right condyle had been previously removed was perfused with formalin just prior to death in order to obtain immediate fixation of the tissues. The head was then sectioned in the mid-sagittal plane and a roent-

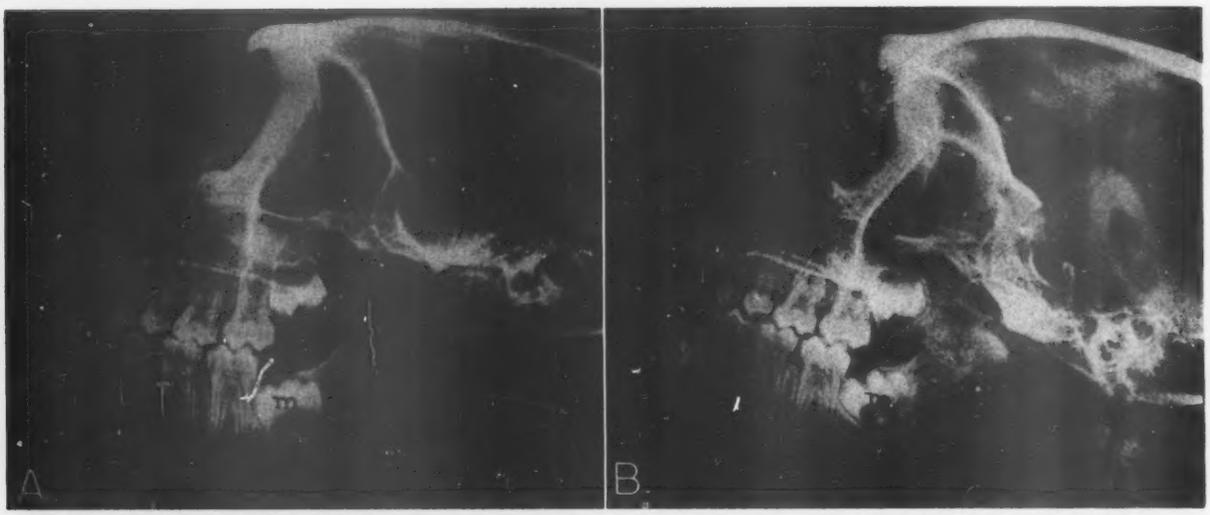

FIG. 3. Lateral roentgenograms (with one reversed for convenience of comparison) of each half of mid-sagittally sectioned skull of monkey number 5. The right mandibular condyle was removed surgically at approximately eight months of age. The animal was sacrificed at thirty-nine months of age with a postoperative survival of thirty-one months. A, unoperated left side. Note body and ramus height, vertical position of unerupted molar (m) and relationship of condyle (c) to the fossa. B, right side, mandibular condyle removed thirty-one months before death. Compare with unoperated left side (A) and note general form, and lesser ramus and body height. The unerupted molar (m) is inclined anteriorly, impacted and in a relatively higher position in the ramus. The false joint is in a markedly anterior position.

genogram was taken of each half. They were then decalcified and sections of the left temporomandibular joint and the right temporomandibular joint area were made for microscopic study.

FINDINGS

Mandible and Temporomandibular Joint Areas. The gross and roentgenographic findings of the mandible and temporomandibular joint areas in this group of animals were similar to, but more accentuated than, those of the group with a shorter postoperative survival period. (Table 1, Figs. 2 and 5–7.)

In one animal, section of the skull in the midsagittal plane permitted a more detailed roentgenographic study and comparison of the temporomandibular joint area on the unoperated and operated sides than in the live animal. (Fig. 3.) On the unoperated left side the condyle was resting in the joint fossa posterior to the articular eminence. On the operated right side no condyle was visible. The posterosuperior surface of the ramus was in a more anterior position and appeared to be in the region of the articular eminence. The fossa was not well defined. The ramus was wider and shorter; its coronoid process was wider and relatively higher than on the unoperated side. The superior surface of the ramus was irregular and a less radiopaque area adjoined it and the skull. The mandibular angle was less obtuse and the preangular (or antegonial) notch was more accentuated. The unerupted molar crown was impacted. (Figs. 2 and 3, Table 1.)

Histologic study of the unoperated left temporomandibular joint of monkey number 5 at the approximate age of thirty-nine months revealed essentially the findings of a normal joint and growing condyle. (Figs. 4A and 4B.) Study of the right side, from which the condyle had been removed thirty-one months prior to death, revealed the articulating surfaces with no disk interposed. (Fig. 4C.) There was no evidence of cartilage being transformed to bone in the condylar-like area, but rather a layer of dense fibrous tissue which was attached to the ramus inferiorly and articulated with the temporal bone superiorly.

Anterior Aspect of Skull. A marked asymmetry was noted in those animals in which one condylar growth center had been removed. (Figs. 1, 5B and C). On the operated side total facial height and width were less. This was because of lesser growth of all the bony components but, particularly, the maxillary and mandibular ones. The face on the operated side had a rounder appearance than the unoperated

FIG. 4. Photomicrographs of hematoxylin and eosin-stained sections of left and right temporomandibular joint areas of monkey number 5. The right mandibular condyle was resected at eight months of age. The animal was sacrificed at thirty-nine months of age. t, temporal bone; as, articular space; d, disk; fc, fibrous covering of condyle; cz, chondrogenic zone; pc, proliferating cartilage; b, bone of condyle; f, fibrous tissue of false joint; r, upper part of remaining ramus. A (original magnification × 20) and B (original magnification × 120), left unoperated temporomandibular joint. Histologically, this joint appears to be within normal limits. Active growth of bone is occurring in the epiphyseal-like area of the condyle. C, area from which right mandibular condyle was resected. Note that there is no chondrogenic zone giving rise to bone in this false joint. As a result of removal of the actively growing condyle, a functional false joint resulted entirely devoid of a cartilaginous growth center (original magnification × 20). There is some apposition of bone, however, at the junction of the fibrous tissue (f) and the bony ramus (r). The wide zone of fibrous tissue serves as a substitute for the removed condyle and neck.

side, which appeared longer and flatter. The maxilla was shorter and narrower, and the plane of occlusion of the teeth was higher than on the unoperated side. Thus, the plane of occlusion was considerably closer to the level of the zygomatic arch and the external auditory canal on the operated than the unoperated side. Because of the smaller maxilla on the operated side the maxillary sinuses were examined to determine whether or not they also varied in size. No definite conclusions could be made, however, because of the small size of the sinuses. The mandible appeared to be swung toward the operated side. On the unoperated

FIG. 5. Anterior view of skulls of three growing monkeys with jaws in occlusion. A, control animal number G-2. Note symmetry of face. B, animal number 6. The right condyle was resected fourteen months before death, resulting in asymmetry of the face. Note shift of the mandible toward the right side, as evidenced by relationship of the upper to the lower incisors. Also, note that downward growth of the left side of face is greater than the right side (see Fig. 1). C, animal number 13. The right condyle was resected twenty-nine months before death. Note on the operated right side the lesser amount of total facial height, the relatively lower level of the zygomatic arch, the lesser height of the ramus, and length and height of the body. These differences are more accentuated than those in (B), which had a postoperative survival of fourteen months (see Figs. 6D and 8B).

side, ramus and mandibular body height and mandibular body length were greater.

Lateral Aspect of Skull. Comparison of the lateral view of skulls of growing monkeys, in which the mandibular condyle had been excised, with the opposite unoperated side or control animals revealed striking differences. (Fig. 6.) Facial height and length were less on the operated side. Whereas, on the side with the intact condyle, the zygomatic arch and external auditory canal were in the region of the middle of the skull well above the inferior border of the maxilla, on the operated side they were in the region of approximately the junction of the middle and lower thirds of the skull at about the level of the inferior border of the maxilla or even the occlusal plane of the teeth. Furthermore, on the operated side the ramus was shorter and wider, and its upper posterior border, which lacked a condyloid process, was more anterior to the articular eminence than on the unoperated side. The sigmoid notch was lacking and the coronoid process was wider, larger and constituted a much larger part of the ramus. The coronoid process was also directed more posteriorly and above the zygomatic arch, on the side from which the condyle had been removed. Although the distance from the superior surface of the coronoid process to the lower border of the mandible appeared to be somewhat less in the operated than the unoperated animals, the distance from the articular surface to the lower border of the mandible was markedly less. The mandibular angle was less than 90 degrees on the operated side and more than 90 degrees on the unoperated side. The antegonial notch was more accentuated, maxillary and mandibular body height were less, and the crowns of the teeth had not erupted as much on the operated side.

Basal Aspect of Skull. Examination was made of the ventral surface of the base of the skulls of growing monkeys in which one mandibular condyle had been resected, with the mandibles articulated and in occlusion. (Fig. 7.) This revealed that, on the side from which the condyle was removed, the upper posterior border of the ramus was markedly anterior and in the region of the temporosphenoidal suture. There was a space of about 3 to 5 mm. between the operated surface of the mandible and the skull. This was filled with fibrous tissue at the time of dissection. (Fig. 4C.) The unoperated side of the mandible appeared longer and the chin was markedly directed to the operated side.

Examination of the basal aspect from the ventral surface of skulls of these monkeys revealed that the anterior and posterior parts deviated toward the operated side. (Fig. 8.) On the operated side the following findings were noted: the maxillary teeth were less well

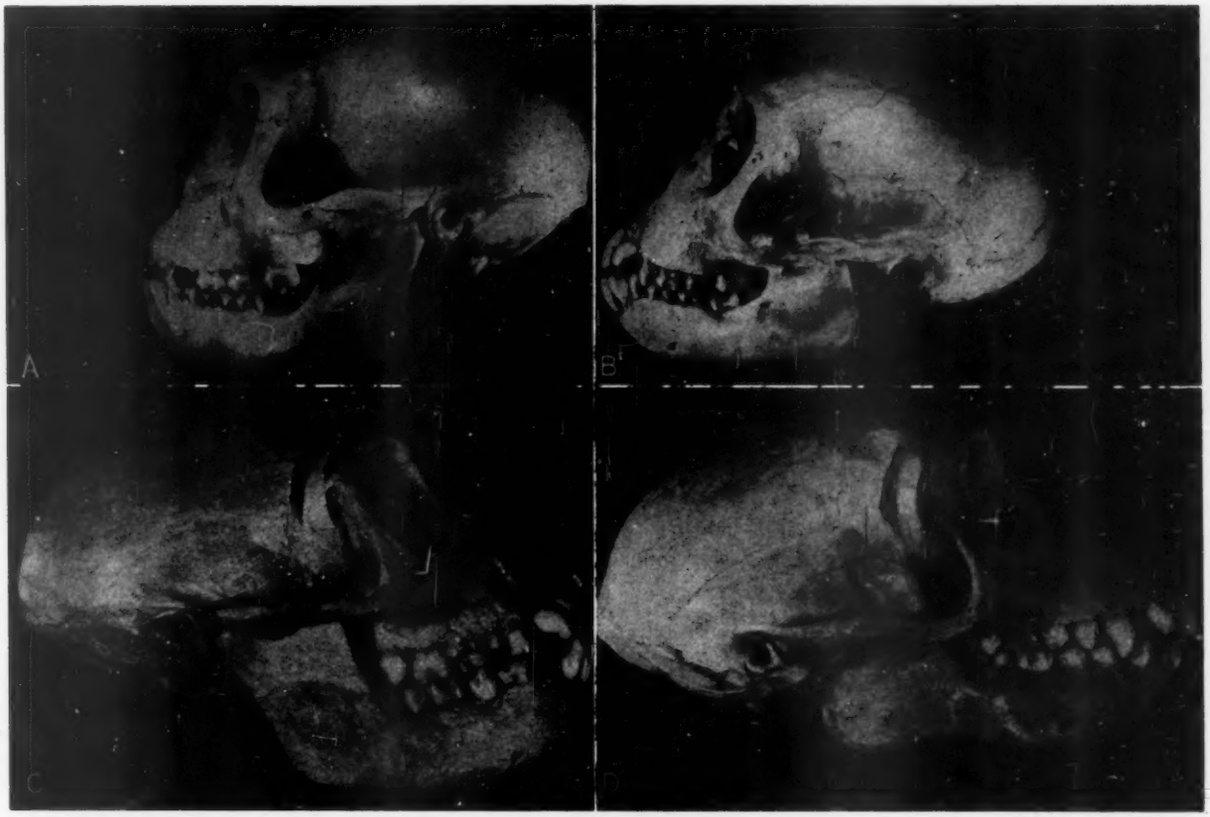

FIG. 6. Lateral view of skulls of four growing monkeys with jaws in occlusion. A, unoperated animal number G-1. Note the condyle, c; its position in the articular fossa, o; the articular eminence, e; the postglenoid process, p g; height of ramus, relation of posterior border of ramus to fossa and the mandibular angle. The coronoid process does not extend above the zygomatic arch. B, animal number 12, approximately the same age as animal number G-1. Both condyles were resected seventeen months before death. Note the lesser total facial height; no true condyle, fossa or articular eminence visible; the considerably wider and heavier coronoid, directed more posteriorly and above the zygomatic arch; the shorter, wide, anteriorly positioned ramus (and coronoid); the relation of posterior border of ramus (region of sphenotemporal suture) to where the true fossa should be; the mandibular angle, which appears to be 90 degrees or less; the accentuation of the antegonial notch and the lesser height of the mandibular body. Compare with (A) and (D). C and D, animals of comparable age with permanent dentition, but older than animals in (A) and (B). C, unoperated animal number 2. D, animal number 13. The right condyle was resected twenty-nine months before death. Compare with (C) and (B) (animal of only seventeen months' postoperative survival). Also, see Figs. 5B and C.

erupted and the palate appeared to be somewhat higher; the palatine foramen was more anterior and appeared to be larger; the horizontal plate of the palatine bone was more anterior; the great wing of the sphenoid was smaller; the zygomatic arch was shorter, more curved, did not extend as far posteriorly and appeared heavier; the temporal bone was shorter and not as wide; the articular eminence, the fossa and the postglenoid process of the temporomandibular joint were either less well developed or absent and in a more anterior and medial position; the external auditory canal was in a more anterior position; the carotid canal and the stylomastoid foramen were also in a more anterior position, as was the posterior part of the temporal bone. Examination of the dorsal aspect of the base of the skull, after removing the top of the skull, revealed no significant differences between the left and right sides.

COMMENTS

Facial Growth. The neurocranium and the masticatory facial skeleton are integrated into an anatomic and biologic unit. Whereas growth of the neurocranium is dependent upon that of the brain itself, the masticatory skeleton is, in part, dependent upon muscular influences, growth of the tongue and the dentition. These

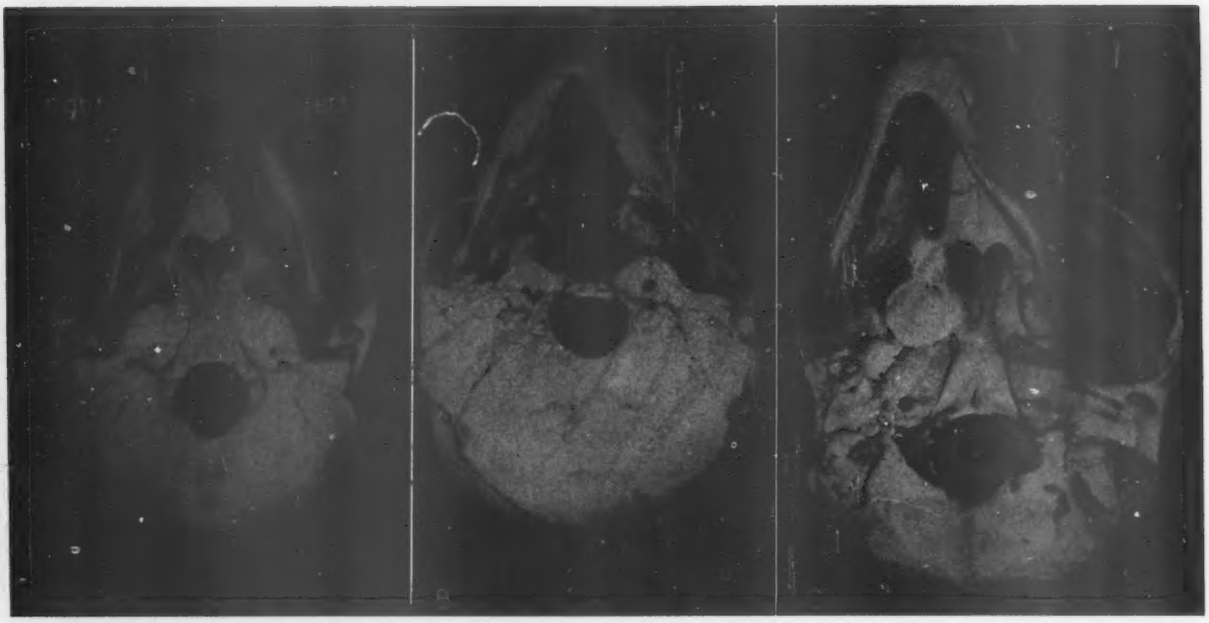

FIG. 7. Ventral view of skulls of three growing monkeys with jaws in occlusion. A, control animal. Note the width of the condyle and its position in the glenoid fossa, prominence of postglenoid process, and smooth posterior border and symmetry of mandible. B, animal number 7. The right condyle was resected three months and twenty days before death. Note on the right side the increased distance of the articulating surface of the mandible from the temporal bone and the position of the left normal condyle in the fossa. The postglenoid process is not prominent. C, animal number 4. The right condyle was resected twenty-five months before death. Note on the operated right side that the mandible articulates with the temporal bone anterior to the fossa and that the body is shorter than the unoperated left side, so that the entire mandible is directed toward the operated side. These differences are more accentuated than in the animal in (B), which had a shorter postoperative survival (see Fig. 8A).

two parts of the skull follow different paths of development and the timing of their growth rates is entirely divergent. Nevertheless, growth of any one part of the skull is co-ordinated to the growth of the whole [5].

Growth of the facial skeleton shows, in many ways, independent curves in space and time. An important variation is a result of differences in the essential mechanism of growth of the upper facial skeleton (sutural) and that of the mandible (endochondral). During the growth period the facial skeleton increases in all three dimensions of space, namely, height, width and depth. The detailed way by which the co-ordination and simultaneity of the enlargement of the face in the three planes are achieved is one of the fascinating chapters of biology [5].

The more important sites of growth for the maxillary complex are three sutures on each side: the frontomaxillary suture between the frontal bone and the frontal process of the maxilla; the zygomaticomaxillary suture between the maxilla and the zygomatic bone (and, secondarily, the zygomaticotemporal suture in the zygomatic arch); and the pterygopalatine suture between the pterygoid process of the sphenoid bone and the pyramidal process of the palatine bone [6]. It is significant that these three sutures are parallel to each other and all are directed from above and anteriorly, downward and posteriorly. Thus, growth in these sutures will have the effect of shifting the maxillary complex downward and anteriorly.

The downward and forward growth of the subnasal part of the maxillary body is accompanied by eruption of the teeth and apposition of bone at the free borders of the alveolar process. Thus, the apposition in this area contributes to the increase in height of the upper facial skeleton. At the same time, the downward growth of the alveolar process accounts for the transition from the flatly curved palate of the infant to the highly arched one of the adult. The downward shift of the hard palate by resorption on its nasal and apposition on its oral surface tends, however, to obscure the downward growth of the alveolar process. Thus, the pathogenesis of the high palate seems to start with a deficiency of the modeling resorption at the nasal floor and with a failure of the

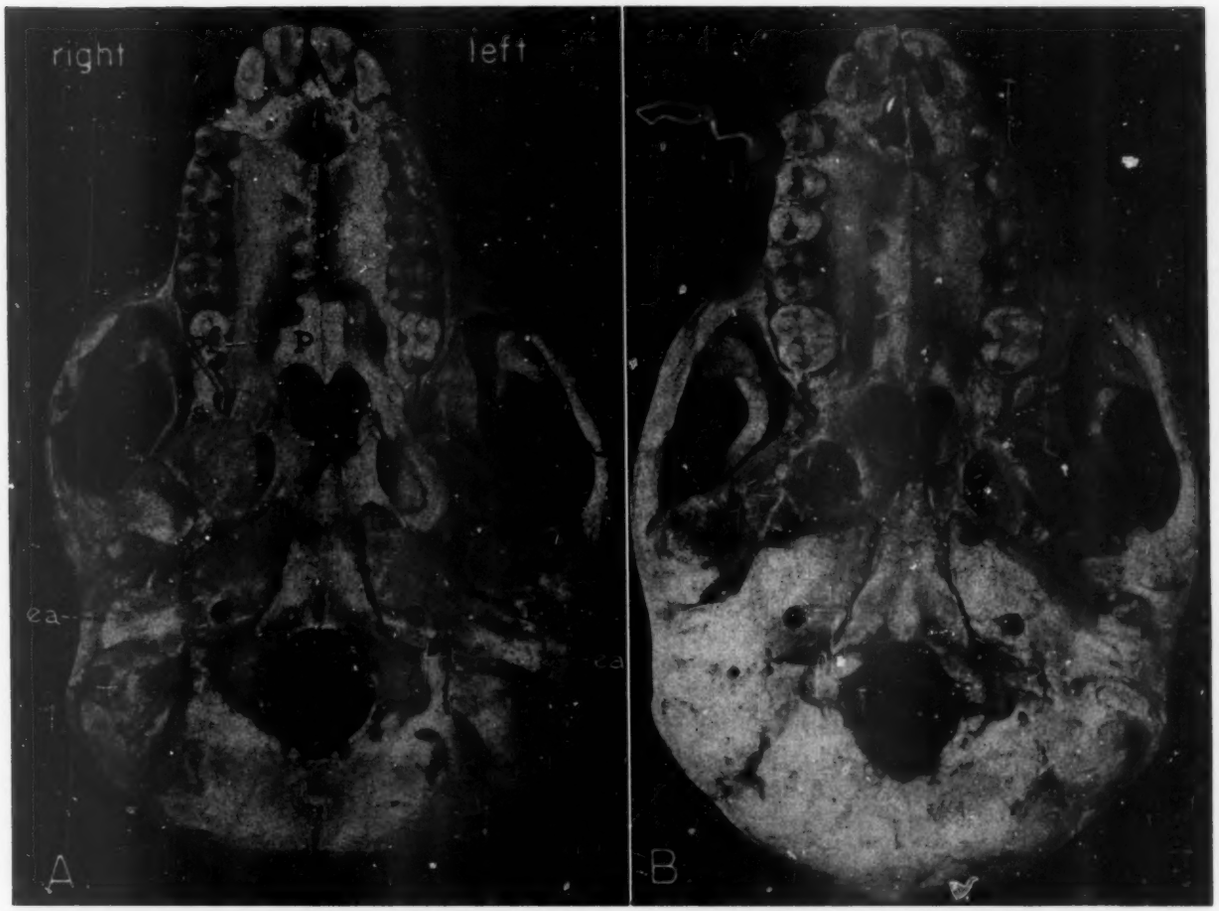

FIG. 8. Ventral view of skulls of two growing monkeys whose right mandibular condyles were resected in (A), animal number 4, twenty-five months before death; and in (B), animal number 13, twenty-nine months before death. p, horizontal plate of palatine bone; pf, palatine foramen; s, great wing of sphenoid bone; z, zygomatic arch; fo, articular fossa; pg, postglenoid process; t, temporal bone indicated by broken line; ea, opening of external auditory canal. Note that the right border appears to be shorter than the left one and that the anterior and posterior parts of the skull tend to veer toward the right side. The maxillary teeth on the left side have erupted more than the ones on the right side and are inclined lingually. The palate on the left side appears to be slightly lower, and the horizontal plate of the left palatine bone is more posterior than the right. The left zygomatic arch extends more posteriorly, and is longer, thinner and straighter than the one on the right. There is no semblance of an articular fossa in the right temporal bone and the remaining right postglenoid process is not as far posterior as the left one. The external auditory canal is more posterior on the unoperated left side.

normal downward shift of the hard palate. The vertical growth of the alveolar processes at the free borders, however, continues in correlation with the growth of the mandible and accentuates the discrepancy.

Growth of the upper facial skeleton is closely correlated with that of the mandible. As a matter of fact, from the findings in this experiment, mandibular growth can even be considered to be a leading factor of facial growth. The mode of mandibular growth, however, is entirely different from that of the maxillary part of the face. In the latter, the growth is primarily sutural. In the mandible, however, the main growth center is the hyaline cartilage in its condyle. These differences explain a certain independence of the growth of these two parts of the facial skeleton.

The condyle is the most important and the most active growth site of the mandible [*1*]. The mode of condylar growth is highly significant since it contributes not only to the increase of the mandibular ramus in height but also to the increase of the over-all length of the mandible. The latter can be measured by determining the distance between the condyle and the chin point (gnathion) [*1*]. Although condylar growth contributes to the over-all length of

the mandible, it does not directly contribute to the increase in length of the mandibular body. Here, appositional growth along the entire posterior border of the ramus is the mechanism for increasing the width of the ramus. At the same time resorption along the anterior border of the coronoid process and the ramus reduces the anteroposterior dimension of the ramus, thereby increasing the length of the body in relation to the growing height of the ramus. Thus, in the growing mandible, what was ramus at one time eventually becomes body. The amount of apposition at the posterior border, which is the second most active site of growth of the mandible, is greater than the amount of resorption of the anterior border, thereby increasing total ramus width. Appositional growth at the tip and posterior border of the coronoid process keeps pace with the increase in height of the ramus. Since the two halves of the mandible diverge posteriorly, the growth of the mandible in its anteroposterior diameter is necessarily associated with an increase in transverse diameter or intercondylar distance. Increase in the transverse diameter is correlated with the increased temporal growth of the skull.

The growth of the mandible at the condylar cartilage is indispensable for the normal vertical growth of the upper face. Upward and backward growth at the condyle, which rests against the articular fossa of the temporal bone at the cranial base, results in movement of the entire mandible downward and forward, so that the upper and lower teeth and alveolar processes become more distant from each other. Since the teeth maintain occlusion by continued vertical eruption, the alveolar processes grow at their free borders. Disorders of mandibular growth, therefore, lead secondarily to changes in the upper face. They generally involve only the subnasal part of the maxilla.

The height of the mandibular body, measured from the lower border of the mandible to the free border of the alveolar process, increases primarily by apposition of bone at the free borders of the alveolar process, which grows into the space created by the growth of the mandibular ramus in height. This experiment demonstrated that with inhibition of increase in ramus height, increase in maxillary and mandibular body height were concomitantly inhibited. The roles played by the alveolar processes and mandibular bone proper are quite different. The important feature of alveolar bone is its ability to serve the needs of the ever-changing requirements of the teeth. In contrast, however, the formed mandibular bone is relatively inactive, although there are changes in proportion by surface apposition. It should be remembered, however, that there is some apposition of bone at the lower border of the mandible.

Facial Growth and Tooth Eruption. The correlation of teeth and jaws has often been interpreted as indicating that the presence of teeth in a proper number and relation is necessary for the normal growth of the jawbones. This assumption is erroneous. It has been observed that the development of the teeth and that of the jaws are highly independent [*1,4*]. In cases of anodontia, in spite of a total lack of teeth, the jaws develop to a fairly normal size [*7*]. No alveolar process, in the strict sense of the word, develops if teeth are absent.

There is, however, a harmonious relationship between dental development and growth of the mandible. Normal eruption of the posterior teeth is entirely dependent upon normal growth of the mandibular ramus which, in turn, is dependent upon activity of the condylar cartilage. In growth of the jaws the only part subservient to erupting teeth is alveolar bone. The growth of the facial skeleton influences the eruption of teeth because the growth of the maxilla and mandible, in an anteroposterior direction, provides the space necessary for the successive eruption of the posterior teeth. For example, the posterior mandibular teeth begin their development in the center of the ramus. The crowns finally become exposed and erupted from the body of the mandible as a result of the progressive resorption of the anterior border of the ramus. Furthermore, the growth of the maxilla and mandible in height, initiated by the vertical growth of the mandibular ramus, is necessary for the continued free vertical eruption of the teeth.

Variations and Anomalies of the Face and Neurocranium. Biologic plasticity is characteristic of bone tissue wherever found. The growing skeleton, however, has a much greater adaptability to changes in form and function than does the adult skeleton [*5*]. The final molding and evolution of the structure of these bones is patterned by growth under the influence of normal function. Thus, a change in function in the growing bone leads to a change in growth pattern, with ultimate extensive

changes in form and structure in a relatively short time. The primary alteration in form and function are followed by mathematically determinable changes in the outer shape and the inner architecture of the involved bone (Wolff's law). This law is based on the fact that each bone is, in shape and architecture, fully adapted to the mechanical forces which act upon it.

The variations of the facial skeleton can be classified into two main categories. The first category deals with the differences in proportion of facial height and breadth, the second category with the variations of the facial profile angles [*8*]. The extreme types of the high and narrow and of the low and broad face are explainable by the leading role which the mandibular condyle plays in the development of the facial proportions. The different rate of cartilaginous growth of the mandibular condyle is responsible for variation in length of the ramus and the different rate of vertical eruption of teeth under varying conditions. The more cartilaginous growth is accentuated, the higher the mandibular ramus will be and, thus, the entire face. Height of the mandibular ramus determines not only the variations of the mandible itself but also those of the upper facial skeleton. While the mandibular ramus gains in height, by proliferation of the condylar cartilage, the body of the mandible moves away from the cranial base and the maxillary body. Into the widening vertical space the teeth erupt with more formation of alveolar bone, so that the mandibular and maxillary alveolar processes grow toward each other. Inhibition of this growth, as in loss of activity of the condylar growth center, results in a shorter ramus, causes an under-eruption of the teeth, less development of alveolar bone and, therefore, less height of the maxilla and mandibular body. The zygomatic arch is shorter and rounder. The face is rounder on the affected side. (Fig. 1.)

It is interesting to observe how the loss of the condylar center of growth is compensated for by the considerably modified pattern of growth in shape and size of the skull. The changes occurring in the mandible after condylectomy are a result of the growth arrest and the new articulation being subjected to forces which differ in direction, and probably strength, from the normal forces. In adaptation to these changes in functional stress, the bone is remodeled in part, so that the direction of spongy trajectories is made to coincide with the new lines of pressure and tension. (Fig. 2.)

Although the growth of the mandible is to a high degree dependent on that of the condylar cartilage, mandibular growth does not entirely cease if the condylar cartilage has been destroyed. In those cases, for instance, which occur early in life, the mandible and face attain a characteristic shape. Although the mandible grows, it never gains normal size. The distorted growth of the mandible in a condylar arrest of the jaw occurs mainly under the influence of growth and function of the tongue and pharynx. The pattern of growth is now entirely dependent upon the apposition of bone at the outer surfaces and modeling resorption on the inner surfaces. Both of these processes are lessened.

Normally, the coronoid tip is at the level of the zygomatic arch. When the condyle is removed, however, the coronoid tip is above the zygomatic arch. This has to do with the relation between condylar and coronoid growth. In a normal animal condylar growth causes a downward shift of the mandible. Thus, the tip of the upward growing coronoid process is held at the same level. If, after condylar resection, the downward shift of the mandible ceases, the coronoid process grows visibly upward by apposition. Another factor to consider, particularly in bilateral condylectomy, is the upward pull of the ramus by the muscles of mastication because of lack of condylar support. Thus, the coronoid process becomes relatively prominent. Since the ramus and its processes have failed to maintain posterior growth with the unoperated side, the coronoid tip is directed more posteriorly, no doubt as a result of the temporal muscle pull.

The changes seem to be related not only to the deficiency of the condylar growth center and of ramus growth but also to a lack of direct articulation with the mandibular fossa of the temporal bone. Apparently, the articulation of the growing condyle in the mandibular fossa of the temporal bone exerts an effect on it, as well as the sphenoid and zygomatic bones, which articulate with the temporal bone. The effect of absence of the condyle was demonstrated in the condylectomized animals by a lesser development and posterior progression of the temporal, sphenoid and zygomatic bones. In addition, the mandibular fossa and its

associated processes were either less developed or absent.

Although the findings are striking in these experiments with monkeys of approximately eight to forty-three months of age, even more striking findings would probably be obtained if an experiment were extended over a longer period of time, both earlier and later. The utilization of some of the methods for measuring growth of bones [*9,10*] in problems of experimental (and clinical) surgery concerned with normal and abnormal growth of bones would be of value. It would also be of interest to determine the changes in the musculature (and how these changes affected bone growth) after removal of the mandibular condyle.

SUMMARY AND CONCLUSIONS

The condyle is the most important and active growth center of the mandible. It is the pacemaker and organizer of mandibular growth.

Removal of the mandibular condyle in a group of growing monkeys with a postoperative survival period of as long as thirty-five months demonstrated that not only was there a severe lack of growth of the mandible on the operated side but also that the facial and neurocranial bone complexes were less developed than those on the unoperated side. Consequently, there was a marked asymmetry of the skull in all its aspects.

The basic science information obtained from this experiment suggests a number of possible clinical applications in this field of plastic surgery.

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Energy Considerations

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THE change in the actin of muscle from a longitudinal cylindric to a globular molecular form shortens it. This, together with heat production, is the energy release of muscular contraction. The appearance of active or free acetylcholine at the muscle end-plate causes this transformation in configuration by releasing adenosinetriphosphate (ATP) which forms an actomyosin ATP complex from actomyosin. ATP contains instantly available high energy phosphate bonds (*vide infra*).

The Krebs tricarboxylic acid cycle releases the bound energy of sunlight stored in fats, proteins and CHO to yield 18 net high energy phosphate bonds (one is used to prime the cycle). These are stored as "quanta" of high energy ATP. The process is termed coupled phosphorylation, and takes place in the grana of the cell. Three ATP bonds are formed for every atom of O_2 utilized. When O_2 is added to a molecule, an atom of H_2 is displaced and there is loss of an electron. This electron loss is energy liberation—the crux of the whole matter. Reduction is removal of an O_2, addition of H_2 and addition of an electron. If one starts with a carbohydrate glycogen, energy storage in the form of high energy phosphate bonds is brought about by the following transformations:

glycogen	phosphorylases	glycose-1-phosphate
	mutases	glucose-6-phosphate
	isomerases	fructose-6-phosphate
	phosphofructokinases	fructose-1,6-diphosphate
	aldolases and isomerases	3-phosphoglyceraldehyde
	phospho-dehydrogenases	3-diphosphoglyceric acid
	transphosphorylases	*2 ATP formed*
		3-phosphoglyceric acid
	mutases	2-phosphopyruvic acid
	transphosphorylases	*2 ATP formed*
		pyruvic acid
	transphosphorylases	*3 ATP formed*
		acetyl coenzyme A (this can come from fat or protein)
	condensing enzymes	oxaloacetic acid citric acid
	dehydrogenases	isocitric acid
		3 ATP formed
	dehydrogenases	alpha-ketoglutaric acid
		4 ATP formed
	dehydrogenases	succinic acid
		2 ATP formed
	fumarases	fumaric acid
	fumarases	malic acid
		3 ATP formed
	fumarases	oxaloacetic acid

The CO_2 produced is expired, converted to urea or bicarbonates; O_2 is utilized and energy produced and stored as described heretofore.

Again the role of O_2 in ATP formation can be visualized in photosynthesis.

In the presence of the energy of sunlight through the action of dehydrogenase coenzyme I:

$$H_2O + DPN_{ox} \dashrightarrow DPN_{red} + -\tfrac{1}{2}\ O_2$$

In the absence of light:

$$DPN_{red} - + -\tfrac{1}{2}\ O_2 - + -3\ ADP - + -3\ PO_4 \dashrightarrow 3\ ATP + DPN.H_2O$$

The other method by which radiant bound energy is utilized by the cell is fermentation. Muscle cells use both methods. Here glucose is converted to lactic acid without O_2; in the yeast cell, glucose becomes ethyl alcohol, which is just a revamped lactic acid molecule. Fermentation, however, is wasteful and is approximately $\frac{1}{30}$th as efficient as oxidation in the liberation of energy. Nevertheless, since the energy of the disease neoplasia comes from fermentation and not oxidation, it behooves the clinician to familiarize himself with this phenomenon. When cells revert to this primitive method of metabolism irreversibly, true neoplasia has developed. It is also of interest to observe that this process of fermentation goes on in the cytoplasm and not in the nucleus. Oxidation of course occurs in the mitochondria.

A brief summary of the role of vitamins in the oxidation reduction mechanism of the Krebs cycle follows:

Thiamine is important in oxidation reduction by acting on alpha-keto acids (pyruvic) through decarboxylase. Thiamine forms pyrophosphate (cocarboxylase), the coenzyme or prosthetic group of decarboxylase.

Riboflavin is the prosthetic group of the flavoprotein enzymes used in oxidative processes. Its consumption varies with the amount of protein metabolism.

Niacin is contained in coenzyme I and II used in H_2 transport and in CHO metabolism. Tryptophan can be a niacin precursor and also varies with protein metabolism.

Pantothenic acid is the prosthetic group of acetylation and is important in adrenocortical function.

Pyridoxine is used in amino acid decarboxylation and deamination, and is important in anabolism.

Folic acid and B_{12} are important in hematopoiesis and B_{12} in transmethylation as well.

Ascorbic acid is important in detoxification and intercellular colloid formation. It is a requirement of venular-vascular fragility, tissue repair and adrenocorticoids. The liver converts vitamins into enzymes.

The role of potassium (K) in the transport of O_2 and CO_2, and hence its indirect influence in oxidation reduction and energy release, may be succintly summarized as follows:

In the tissues:

$$KHbO_2 \dashrightarrow KHb - - O_2$$
$$KHb - - H_2CO_3 \dashrightarrow KHCO_3 - - HHb$$

In the lungs:

$$HHb - - O_2 \dashrightarrow HHbO_2$$
$$HHbO_2 - - KHCO_3 \dashrightarrow KHbO_2 - - CO_2 - - H_2O$$

In the tissues (CL shift):

$$H_2CO_3 - - NaCl \dashrightarrow NaHCO_3 - - HCl$$
$$HCl - - KHb \dashrightarrow KCl - - HHb$$

In the lungs (CL shift in reverse):

$$KCl - - HHbO_2 \dashrightarrow KHbO_2 - - HCl$$
$$HCl - - NaHCO_3 \dashrightarrow NaCl - - CO_2 - - H_2O$$

"Potassium hypoxidosis" is the term used by the author to describe the train of events seen clinically in hypokalemia, as is well exemplified in postoperative potassium loss with a relatively sudden onset of signs and symptoms when the critical level of interference in tissue metabolism is reached due to impairment of O_2 transport and utilization, and concomitant interference with CO_2 elimination. The intracellular potassium exists in a two-compartment phase, i.e., a low phase of approximately 5 mEq./L. and a high phase of approximately 50 mEq./L. The biphasic phenomenon is much less apparent for sodium.

It is suggestive that low potassium perhaps affects the specific conducting tissue of the heart through its importance in the oxidation reduction mechanism of the specific cells. The lessened effectiveness of digitalis in hypokalemia may be on a similar basis.

From the extracellular fluid, a lake of intermingled fibrils, "free and bound water," electrolytes and proteins, O_2 passes through the junctional zone commonly called the cell membrane to the interior of the cell. The blood brings the O_2 to this extracellular fluid compartment from the alveolar capillary. The O_2 diffused across the 0.1 micron thick alveolar membrane from the alveolar gases. Here its concentration was approximately 14 per cent at a partial pressure of 105 mm. of mercury. The CO_2 concentration in the alveolus is approximately 5 per cent at a partial pressure of 40 mm. of mercury. Its course through the body follows that of the O_2 in a reverse direction. As a matter of fact, CO_2 elimination is every bit as important as O_2 utilization; but since

it does not color the blood and so the patient (unless it be to make the patient paler), its significance is often missed. Carbon dioxide is transported simultaneously from the cell to the alveolus by the same mechanism as that utilized by O_2 transport.

CO_2 is approximately twenty-five times more diffusable than O_2, and so the alveolocapillary membrane allows its diffusion long after disease has impaired O_2 diffusion. The association S-shaped curve of O_2 becomes a linear function when plotted for CO_2. As the PCO_2 increases, the CO_2 content increases proportionately, and vice versa, whereas the O_2 content does not increase nor decrease significantly over a long range toward the right of the classic curve. The cardiac intracellular potassium content varies greatly with the plasma CO_2, decreasing as it increases. This is probably accompanied with a change of "bound" to "free" Ca+, and intracellular dehydration due to an outward water shift. This increased intracellular free Ca+ may be very significant in cardiac arrest where anoxia is usually blamed but where hypercapnia may be more significant.

To the clinician, be he surgeon or internist, the foregoing discussion has practical significance. The role of vitamins in the cellular oxidation reduction mechanism is obvious. Perhaps it is not so apparent that ten times the normal requirements are needed in disease with its catabolism followed with anabolism and increase in O_2 utilization from a normal of 200 to 1,000 ml. per minute.

Today the surgeon, internist and anesthetist are all finding it necessary to take cognizance of the mode of effect of various agents upon energy release. Hibernation, hypothermia and hypoxia, to mention intensely practical examples, owe their importance to the alteration produced in the release of high energy bonds. The O_2 uptake of the organism which varies directly with the rate of oxidation in the body can be followed by rapid optical (photocolorimetric) analysis of the pyruvic acid content and is governed by the energy utilized. The general causes of hypoxic hypoxidosis are: (1) hypoxemia such as occurs at high altitudes, (2) ischemia due to vasoconstriction, (3) anemia.

Oxidation in the brain is interfered with through the following means: (1) diminished supply (poor ventilation under anesthesia, failing cardiac output, anemia, hemorrhage, vasoconstriction, etc.), (2) decreased supply of substances which utilize the O_2, as in hypoglycemia, (3) deficiency of respiratory enzymes such as occurs in beri-beri, (4) enzyme toxins such as cyanides.

Consciousness is lost in eight seconds if no O_2 is supplied to the brain, and this becomes irreversible in three to three and a half minutes. The normal venous PO_2 is 95 mm. of mercury. When this is reduced to 19 mm., which results in 13 mm. at the points in the brain farthest from the capillary wall, irreversible brain damage occurs. The normal brain O_2 requirement is 2.8 ml./100 gm./min. If this is reduced to 18 per cent, survival is impossible. In the newborn all these survival times are lengthened because they vary with the surface area of the sum total of the dendrites which is much less in the newborn. The discussion has referred to brain tissue at a body temperature of 37°C.

When the body temperature is lowered, the O_2 and CO_2 requirements decrease in an exponential manner until 30°C. is reached, after which they all increase again following the same mathematical function.

Hibernation, on the other hand, is based upon endocrine changes and is an entirely different phenomenon.

Shivering increases the O_2 demands due to the energy requirements of the work involved, and is of course prevented by light ether analgesia in cardiac surgery. (This is the third phase of the first plane of anesthesia.)

"The heart is the first to live and the last to die; the brain is the last to live and the first to die."

Alkaloids and anesthetics inhibit the dehydrogenases while sulfides, cyanides, carbon monoxides, etc., inhibit the oxidases, both of which are part and parcel of the Krebs cycle. When one remembers that these agents act on the specific conducting tissue of the heart, it is obvious how lethal "sedatives" such as 0.2 gm. sodium amytal® may be in a preoperative mitral. In such an instance a single fiber may be all that is functioning and yet may show as a normal conduction system.

Today, when cardiac arrest is so much to the forefront, one should carry some theoretic knowledge as to its possible basic mechanism beyond the much discussed factors of CO_2 alterations, O_2 reduction and vagal stimulation. Models of pure muscle fibrils (free from connective tissue, lymph, etc.) go into a state of rigor when completely free of ATP. This is analogous

to the extreme hardness and fast fibrillar movement felt by the hand in a heart in ventricular fibrillation before arrest. Immersion of the model in ATP (if inhibitors are used to prevent contraction) now shows the "plasticizing effect" causing the fibrils to become plastic due to the binding of ATP to actomyosin. Pyrophosphate is also a plasticizer and prevents the rigidity caused by ATP removal. Perhaps these two phenomena have direct clinical application.

In the exergonic (energy-yielding) process ATP is being split, and contraction continues only while this is occurring. This represents the conversion of energy to work. The energy required for other endergonic processes, such as ciliary movement, fibroblast and epithelial contraction of mitosis, chemical biosynthesis of complex molecules and osmotic work as exemplified in secretory activity such as tubular potassium reabsorption or zymogen release, is provided and stored in the same way, namely, by ATP.

Relaxation sets in when this ATP breakdown is inhibited. What inhibits this process? Excess ATP, ionic concentrations of supraoptimal values and the M.B. (Marsh-Bendall) factor are the clinically important inhibitors. Salyrgan® inhibits splitting. The M.B. factor is a normal living muscle protein which constitutes the physiologic regulator of this mechanism. The M.B.-inhibited splitting of ATP can be restored by caffeine, calcium chloride and cysteine. The clinical importance of this is apparent if one realizes that cardiac arrest is fibrillar relaxation prolonged.

If a fibril is now allowed to contract, the energy is utilized in the production of tension (isometric ventricular contraction). This varies directly with the temperature. The constants of the function depend on the specific actomyosin (different muscles vary differently with temperature but all vary directly). The same laws hold for contraction. If fibrils in isometric contraction (under tension alone) are now allowed to shorten 10 per cent of their initial length, the tension drops to zero (is abolished) but it immediately rises again. This is termed the quick-release phenomenon (this does not occur in elastic shortening). Some phase of this is constantly occurring in the muscles of blood vessels and in the myocardium.

It can be shown that contracted models (of muscle fibrils) exposed to a plasticizer pyrophosphate to prevent rigidity, relax as soon as ATP is removed. Here no reaction is occurring to supply energy during relaxation. The clinical counterpart is obvious; the myocardium does not build up energy, rest or recuperate during diastole. Actomyosin receives its energy during contraction, not during relaxation (diastole).

Aerobic cells generate high energy ATP from ADP and orthophosphate by the addition of electrons which are derived from the oxidation of food moieties via the respiratory carriers. This is termed oxidative phosphorylation or a coupled synthesis of ATP. Carbohydrates and fatty and amino acids are broken down into acetyl CoA fragments which in turn are oxidized by the final common pathway of the Krebs cycle yielding high energy phosphate bonds incorporated in ATP, the universal storer and provider of the energy of life.

In the nervous system, for example, the energy required to free bound inactive acetylcholine in the resting nerve is also derived from these high energy bonds. The acetylcholine now acts upon a receptor protein and alters the ionic permeability of the nerve membrane in such a way that sodium and potassium will shift, and by this shift generate an ionic concentration gradient which is in reality an electromotive force and constitutes an action current.

I have started with the very obvious premise that life is associated with energy. The present concept that energy is not a reality is completely ignored, and the calculus of statistical probabilities through mathematical functions is the best means of dealing with the older "mass energy transformations." It has been shown how this force is provided by high energy phosphate bonds through the intermediary of the Krebs cycle.

A Day by Day Analysis of the Fluid, Electrolyte and Nitrogen Metabolism As It Pertains to Parenteral Feeding*

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THE primary object of fluid management and electrolyte control is to have the patient "in balance." The phrase "in balance" is an elusive one, ideally meaning that the output and the input are identical. As with so many theoretic considerations, the ideal in clinical practice may never attain "Ivory Tower" perfection.

In a clinical sense, "in balance" can therefore embrace a great diversity of opinion. For example, individual day-to-day patient differences would make the theoretic ideal of output-input relationship untenable until existing deficits or surpluses were corrected. This period of adjustment in the surgical patient may actually be longer than seemed necessary for the patient's preoperative hospitalization, or it may also be complicated by the patient's condition, his response to treatment or the technical and clinical inability to determine immediately and accurately the patient's needs. These variables must be accepted in clinical investigation, but because of them and in an effort to eliminate preconceived ideas, we have endeavored to use statistical analysis in a relatively large series of accurately studied patients

METHOD OF STUDY

The period of investigation pertains to consecutive days in which the patient was fed parenterally to the exclusion of all other nutrients. Balance studies pertaining to water, calories, nitrogen, sodium, potassium and chlorides were conducted day by day. Blood studies pertaining to plasma, sodium, potassium, chlorides, CO_2 combining power, blood sugar, blood protein, blood urea nitrogen and hematocrit were done every third day.

We have endeavored to keep our ninety-six patients "in balance" every day and consequently the input would be found to be variable, depending on the clinical and laboratory evaluations of the patient's condition.

Inherent in each of the individual studies are the original imbalance and individual patient differences. We, with the knowledge of these differences, have considered the scatter of the patient's input-output relationship from day to day as the patient passes through time—separately for each variable.

We shall illustrate only a few typical graphs, using on the whole a purely descriptive type of analysis dealing with the following questions: (1) How good is the existing method of estimating input needs for all patients? (2) What is the effect of the day of surgery on the patient balance and on postoperative estimation of patient needs?

Two possible methods of considering the day by day scatters for each variable for all patients were possible: first, the input-output scatters for days counted forward (postoperatively) and backward (preoperatively) from the day of surgery; second, a similar input-output relationship preoperatively for the number of days after the beginning of parenteral feeding and a second starting point from the day of surgery.

By use of the first method we considered ten scatters, grouping:

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† National Heart Institute Biostatistics Training Fellow.

Four days and earlier preoperatively
Five days and later postoperatively
Third day preoperatively
Second day preoperatively
First day preoperatively
Day of surgery
First postoperative day
Second postoperative day
Third postoperative day
Fourth postoperative day

Hence, we have ten scatters for each variable—fifty in all.

By use of the second method we considered separately the first, second, third and fourth days after the beginning of intravenous feeding, and grouped the fifth and succeeding preoperative days. The day of surgery and the postoperative days are necessarily the same in both methods. This gave us an additional twenty-five scatters. The reason for grouping was to give a sufficient sample size to merit descriptive analysis.

Using the theoretic principle that the ideal scatter would be one lying on the line of equivalence, we will use as our criterion of "in balance" the approach of the scatter to the line of equivalence. This method is certainly open to criticism for various reasons, but at present there seems to be no better way of analyzing these data.

The terminology we will use is as follows:

1. A circular scatter would be one in which there seems to be little or no relationship between input and output.*

2. An elliptic scatter of varying degrees of "flatness" will similarly show varying degrees of relationship between input and output. (Pictorially this may be described as passing through the shapes of a saucer, an egg, a herring can, a sausage and finally a straight line. A less vivid but more sophisticated definition of flatness is that the ratio of the minor to the major axis approaches 0 in the limit.)

As an example of circular scatter we will use the day of surgery for nitrogen. (Fig. 1.) As an example of relatively high relationship, i.e., a "quite flat" elliptic scatter, we will use the second day preoperatively scatter for nitrogen. (Fig. 2.)

*The use of the phrase "little or no relationship" is not to imply insignificant correlation. It is highly improbable that the population (of which these observations form a random sample) has correlation zero. Computed correlation coefficients already done on these data, when tested by usual statistical methods, yield highly significant statistical results for all five variables. The use of this phrase "little or no relationship" has its implication in practical importance, i.e., what of predictive value can be derived from the relationships? In succeeding works already in progress we will give the best linear relationships so often quoted and referred to as "correlations" between variables. The intent of this article is a descriptive analysis of the trend toward equivalence and not a statistical formulation of the interdependence and the intradependence of the variables; we are requiring here that the form of the scatters be such that their approach to the line of equivalence is visibly obvious and we discount those scatters that are not of "little or no relationship" even though they may have highly significant statistical correlations.

Nitrogen

By the first method the preoperative input-output relationship seems to improve slightly as we pass through time. This would indicate, on the whole, that the patients were approaching "balance" as the day of surgery drew nearer. The scatters went from nearly circular to a flattened ellipse. Most of the patients were in positive nitrogen balance until the second preoperative day, when the number in positive balance became essentially the same as the number in negative balance. (Fig. 2.)

By the second method of analysis we see somewhat similar results except that an elliptic scatter was already present on the day of admission. This elliptic scatter was interrupted on the second and third days after admission, but as all patients neared surgery they seemed to be approaching balance.

On the day of surgery we noticed that the number of aberrant outputs was greatly reduced but that the trend toward the line of equivalence was reversed, and hence the circular scatter was once again present. (Fig. 1.) It was not until the third or fourth postoperative day that the scatter again became elliptic. This occurred even though the magnitude of the variation was very large.

These findings suggest that nitrogen equilibrium is being approached as the patient passes through time although it is definitely upset on the day of surgery.

In some instances the patients were in strong positive nitrogen balance on the day of surgery, whereas in others they were in equilibrium or in negative nitrogen balance. This low relationship on the day of surgery illustrates our inability to predict the nitrogen needs on this day and suggests, in addition, the variability of nitrogen metabolism on the day of surgery.

Fluid

As we move through time, the scatter for fluid input-output approaches the line of equivalence, indicating that our patients are approaching fluid balance. This same general trend is apparent with the second method of analysis. By the first day preoperatively the scatter is definitely flatter; hence we would say that the input-output relationship preoperatively is reflecting the general correctness of the method for estimating the patient's fluid need.

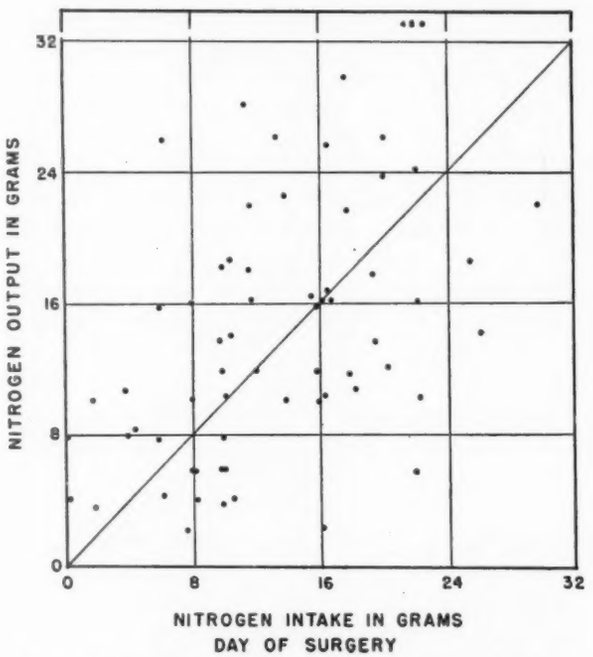

FIG. 1. This represents the scatter of nitrogen intake in relation to nitrogen output on the day of surgery. This is a circular scatter distribution and indicates that on this day there was little or no relationship between input and output. This is the day of "alarm" and, as might be expected, the nitrogen demands were unpredictable.

As with nitrogen, the day of surgery has undone the trend toward balance but the postoperative scatters, day by day, show an increasing relationship even though the average input and output values are definitely increased.

Potassium

There was no apparent relationship when we considered the scatters preoperatively from the day of surgery (first method). By using the scatters from the day of admission (second method) we see a stronger relationship as we move through time. By the third day of intravenous feeding we had the same number of patients above and below the line of equivalence, as opposed to three-fourths in negative balance on the day of admission.

In accordance with popular belief we attempted to reduce the potassium intake on the day of surgery awaiting definite knowledge of the renal excretion. Hence our scatters on the day of surgery indicated, as might have been anticipated, that most persons were above the line of equivalence, indicating negative potassium balance.

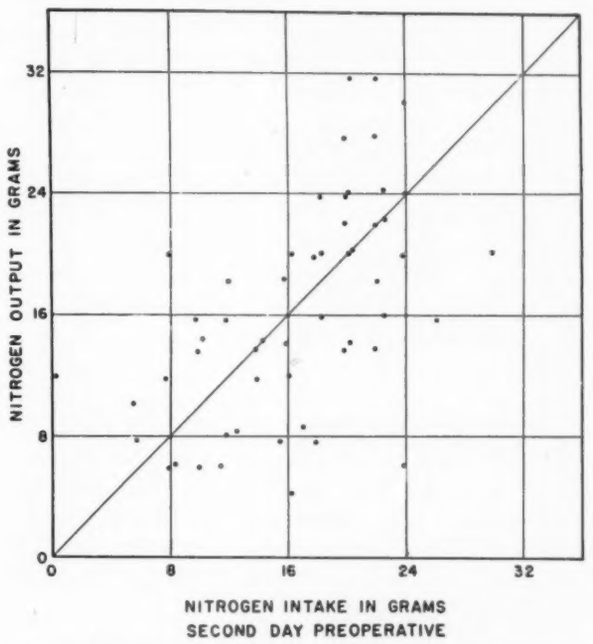

FIG. 2. This represents the nitrogen intake-output relationship on the second preoperative day. This is an elliptic scatter and indicates a high relationship. It indicates that the patients were attaining nitrogen equilibrium.

Following surgery there was no increase of potassium output as we had anticipated. It was not until the fourth postoperative day that we again noticed a major portion of our patients in negative potassium balance.

Chloride

In the scatters for chloride we saw little day-to-day change. Preoperatively almost no trend toward equivalence was detectable. Over all, the most noticeable difference was that the number of patients in *negative* balance was twice the number in positive balance on the day of surgery, whereas conversely, almost three times as many were in *positive* balance postoperatively as were in negative balance.

We did, however, notice an extreme dispersion in the scatters considered from the day of admission. The scatters were nearly circular for the first two days, but for the next two days a slight improvement was noted and except for three divergent cases appeared to have moved toward equivalence. In general it seems that the total amount of chloride given was excessive since the proportion of patients in positive balance increased for each succeeding day. For any one patient such an occurrence might have been construed as an original deficit, but in analyzing the entire group we are led to the opinion that the administered amount of chloride could have been reduced without causing a chloride deficit. This may also suggest a lability of the chloride ion as is also referred to in the sodium ion.

Sodium

Preoperatively the scatter for sodium input-output tended toward the line of equivalence, indicating an improvement in over-all patient balance as the day of surgery was approached.

Considering the scatters from the day of admission, we believe that little can be said about the day by day relationship between input and output for sodium. The dispersion was so great that we believe we would be wiser to refrain from a statistical interpretation.

On the day of surgery, as with the other variables, the scatter was best described as circular, indicating no relationship between input and output.

Following surgery the most noteworthy thing that can be said is that the scatters showed no similarity to the scatters of the other variables and basically little improvement in input-output relationship.

Certainly one gains the impression from these statistical studies of the sodium that there is no clear-cut input-output relationship. One might, on this basis, theorize that sodium equilibrium is not as much dependent on the day-to-day amount of sodium intake and output as it is on the physiologic functions within the body which are as yet unexplained.

SUMMARY

It appears that in general the methods we have used for estimating patients' nutritional needs tend on the average to move the patients toward balance. In many instances, however, the relationships are quite low, indicating many other unpredictable factors to confound our estimates. This is especially noticeable on the day of surgery. It is also evident on the first two or three postoperative days. We are mindful of the cautions of Talbot, Crawford and Butler, who have indicated that the cybernetic mechanisms of the body will go a long way toward maintaining equilibrium if the body is offered reasonable quantities of nutrition, water and electrolytes.

These studies suggest that our estimations of the need for fluid and nitrogen have been more satisfactory than our estimates of electrolytes. The fluid and nitrogen equilibrium was more nearly approached as the patient passed through time, whereas this did not prevail with chloride, sodium and potassium. The chloride intake was, on the whole, somewhat more than was needed, whereas the sodium intake was satisfactory. Both of these electrolytes no doubt were influenced by the day-to-day physiologic variations within the body.

The potassium output was fairly constant as the patients passed through time and was not significantly influenced by the day of surgery or the postoperative convalescence. The potassium intake, as used in these studies, appears to have been adequate.

On the basis of these statistical studies we believe that consideration of the patient balances from three independent starting points gives the best evaluation of the patient's balance status as it develops from parenteral feeding, i.e., preoperative from the first day of intravenous feeding, the day of surgery by itself and the postoperative period beginning on the first postoperative day.

We hope that the foregoing observations will stimulate new research in these directions. Controlled experiments for each variable are needed, but lack of knowledge of the labyrinth of interdependence between variables and within the variables themselves complicates all such attempts. Still we can conclude on the cheerful note that we are gratified to see that generally the patients as a group tend toward equivalence both pre- and postoperatively.

Gastrointestinal Hemorrhage, Its Diagnosis and Treatment

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GASTRIC hemorrhage is an undeniable emergency which warrants immediate and definitive action. The ability to establish the etiology of bleeding frequently taxes one's diagnostic acumen [1]. There is no clear-cut answer to the problem of diagnosis and treatment of upper gastrointestinal bleeding, as can readily be assumed from the voluminous literature that has recently been published on this subject.

The first problem facing the physician when he is treating a case of massive gastrointestinal bleeding is to determine the site of bleeding and the etiology [2], and then take immediate steps to prevent progression of the hemorrhage to a more dangerous degree. In addition to this, he must reach a decision early as to whether medical treatment will be sufficient or whether surgery will be needed [3–5].

As a general rule, it is not too difficult to differentiate between upper and lower gastrointestinal bleeding. This, of course, depends on an accurate history, a thorough physical examination and the availability of adequate reliable laboratory procedures. It is generally believed that no procedure should be omitted which might reveal the exact etiology of the bleeding. Many factors play a role in the ultimate result achieved in the treatment of a case of gastrointestinal hemorrhage. Among them are: (1) general physical condition of the patient at the onset of a hemorrhage, (2) the age of the patient, (3) the rapidity of bleeding, (4) the compensating mechanisms of the body in response to bleeding, and (5) the underlying cause of the bleeding. Occasionally one is confronted not only with massive gastrointestinal bleeding but also a complicating condition such as liver disease [6], pregnancy [7], diabetes, malnutrition, etc. These complicating conditions must be adequately and thoroughly investigated [8–13] and a true evaluation placed upon them before definite decisions are made as to the treatment of the patient, particularly as far as surgery is concerned. Many times surgical procedures on these patients with gastrointestinal bleeding are absolutely necessary in spite of complicating conditions.

In arriving at a definite diagnosis it is always wise to consider the possible etiologic factors. Some of the causes of hematemesis and melena are: peptic ulcer, gastritis, cirrhosis with esophageal varices, gastric carcinoma, esophagitis, blood dyscrasias, coagulation defects, ruptured sclerotic blood vessels, swallowed blood, hiatus hernia, rupture of an aneurysm, congestive splenomegaly, congestive heart failure, systemic infection, carcinoma of the lung with esophageal involvement, Mallory-Weiss syndrome, swallowed objects with gastroesophageal trauma, benign and malignant lesions of the gastrointestinal tract (diverticula, vascular and neoplastic lesions), infectious diseases of the bowel, uremia, vitamin C deficiency, prolapsed gastric mucosa, Curling's ulcer, malignant lesions of the pancreas and biliary system with invasion of the gastrointestinal tract, pseudoxanthoma elasticum [14], irritating substances such as aspirin [15,16], and many more.

We use all laboratory facilities available, even during the acute bleeding episode, in order to establish the bleeding point. X-ray diagnosis using the Hampton technic [9] is of tremendous

value, and spot films should always be taken. Liver function tests should be used [6] if time is available. It must be borne in mind that certain liver function tests will be erroneous if the patient has been in severe shock or is in shock at the time of the test; therefore they must be interpreted with discretion.

TREATMENT

Patients with massive hemorrhage must be watched very closely during the period of treatment. As in external hemorrhage, patient anxiety is pronounced. This should be controlled with mild sedation and transfusion begun without delay [5,17].

In the past it has been thought that intra-arterial transfusion was the procedure of choice. However, recent literature [18] seems to discredit this method and the trend now is toward intravenous transfusion. An immediate complete blood count, urinalysis, and hemoglobin and hematocrit determinations give one a baseline for further evaluation as treatment progresses. However, hematocrit determinations performed after a compensatory interval are more accurate. Blood pressure, pulse and respiration should be taken every five minutes and recorded. An indwelling catheter should be inserted, and a very accurate record should be kept of the patient's intake and output. Vitamin K should be routinely used in fairly large doses early in the treatment, even though in many cases it is of little or no value. A nasogastric tube should be passed into the stomach and continuous suction begun. The amount and character of the material aspirated from the stomach gives one a gross, but not too accurate, means of determining the rate of bleeding. The patient should be placed in the Trendelenburg position, and oxygen given immediately. A cut-down on an ankle vein should be done, and polyethylene tubing inserted. If it is thought that the patient has bled severely, 1,000 ml. of blood should be given fairly rapidly and the hematocrit determination repeated. If there is no significant rise in the hematocrit, it must be assumed either that the patient is continuing to bleed or that sufficient blood has not been replaced. At this time an additional 500 ml. of blood are given and the hematocrit determination is repeated. If the blood pressure does not respond after this initial transfusion, the patient is started on arterenol and the blood pressure maintained above 100 mm. Hg systolic throughout the remainder of the treatment. Details of arterenol administration will be subsequently discussed. It has been our policy to replace only 75 per cent of the blood loss in accordance with recent investigation [19].

If the bleeding is established as being esophageal, a tamponade is used, the Patton-Johnston tube being most satisfactory. It must be realized that the use of the Patton-Johnston tube is purely palliative, and more definitive therapy must be carried out at a later date.

Hemostatic agents have not been used by us to any great extent, but as reported by others, they undoubtedly have a place in certain types of cases.

The criteria used by Hoerr [3] are excellent in determining whether conservative measures should be followed or surgery advised. However, these indications will vary according to the individual case. Briefly, the indications for surgery are: (1) any patient who has received 1,500 ml. of blood or more and then relapses into vascular collapse, (2) any patient over fifty years of age who has bled into shock at any time, (3) a patient who cannot maintain an acceptable blood pressure or hematocrit with a maximum of 500 ml. of blood every eight to ten hours, or (4) a recurrence of massive gastrointestinal hemorrhage. Any patient falling into any one of the above categories should be given the advantage of immediate surgery. The operative mortality in these cases is high. It can be kept at a minimum by proper preoperative evaluation, preoperative preparation, rapid and good surgical technic with adequate supportive measures, and careful postoperative management.

At surgery the primary purpose is to stop bleeding, and in the majority of cases it is wise to terminate the procedure when this has been accomplished. Further definitive surgical therapy should be postponed until the patient is in a more acceptable condition for surgery.

COMMENTS

Most of us will agree that peptic ulcer is the cause of bleeding in the majority of patients with gastrointestinal hemorrhage. Clinically, gastritis and esophagitis account for approximately 35 per cent of the total cases of gastrointestinal bleeding. However, autopsy studies have revealed that gastritis very infrequently causes severe gastrointestinal hemorrhage [2]. Esophageal varices, caused by portal hyperten-

sion, usually accounts for approximately 10 per cent of the cases. It is in the remaining 10 per cent or so, not included heretofore, that one's diagnostic acumen is taxed. Many times a reader is misled by figures regarding the frequency with which the various causes of hematemesis and melena occur. These figures will depend on the material studied by various observers. Naturally, the accuracy of the figures depends on the thoroughness of the investigations. Brick and Jeghers [*1*] recently described very thoroughly the causes of massive gastrointestinal hemorrhage other than peptic ulcer and esophageal varices. A high index of suspicion by the clinician will often lead one to find the rarer causes of hematemesis and melena.

Bleeding in the upper gastrointestinal tract is usually manifested by hematemesis and melena. However, it is not uncommon to see melena without hematemesis in hemorrhage of the upper digestive tract. The occurrence of hematemesis usually depends on the accumulation of blood within the stomach followed subsequently by vomiting. However, repeated episodes of melena without hematemesis usually signify a lesion below the duodenum, which as a rule is more difficult to diagnose. It has been demonstrated by experiments that at least 50 to 80 ml. of blood are necessary to produce a tarry stool [*20*].

Many clinicians attempt to estimate the size of the hemorrhage by signs and symptoms that are present. However, many times this information is misleading. When obvious signs of shock are present (hypotension, thready rapid pulse, marked pallor, restlessness and moist skin), one can assume that serious loss of blood has occurred. The severity of symptoms naturally depends on the rapidity and volume of blood loss. If facilities are available, Evans blue dye (T1824) can be useful to measure the plasma volume accurately.

It has been proved by Schiff [*21*] that the blood urea nitrogen offers a prognostic tool in the evaluation of patients with hematemesis. According to his work, a blood urea nitrogen concentration of less than 30 mg. per cent in patients with hematemesis due to peptic ulcer, hepatic cirrhosis or undetermined cause is a favorable prognostic sign. The presence of a blood urea nitrogen content of 50 mg. per cent or more following hematemesis or melena is accompanied with a fatal outcome in 33 per cent of the cases, and an elevation of 70 mg. per cent or more is accompanied with a fatal outcome in approximately 66 per cent of the cases.

As a rule, the level of the blood urea nitrogen is directly related to the amount of blood entering the upper intestinal tract. Following a single hemorrhage the peak is usually reached within twenty-four hours; and unless the patient continues to bleed or has another episode, it is usually normal by the fourth day. One must be aware that the blood urea nitrogen level may also be affected by such factors as dehydration, starvation or renal disease. However, in the latter instance there will be other findings leading one to suspect a decompensated kidney. Additional renal impairment may occur as a result of shock; however, azotemia following shock would also be associated with other symptoms such as oliguria or anuria.

Fever may also be used as a clinical tool. As a rule the rise of temperature usually occurs within twenty-four hours following a moderate hemorrhage, and usually goes over 100°F. At times the temperature may reach 103°F. If the patient has no further bleeding, the temperature gradually tapers off to normal within the next few days. The fever is probably caused by a foreign protein-like reaction due to the breakdown of blood in the gastrointestinal tract. It is assumed that a thorough history taking and physical examination have been done before vigorous diagnostic procedures are attempted. According to the work of Palmer [*8*], esophagoscopy, gastroscopy and contrast fluoroscopy should be done, in that order, as soon as possible after the patient is admitted to the hospital and replacement therapy is instituted.

Acute gastrointestinal hemorrhage is a medical and surgical problem, and the combined efforts are necessary for the proper treatment of the patient.

Shock, regardless of the cause, is a disproportion of blood volume and vascular capacity. Whether the disproportion is due to loss of blood volume or due to dilatation of the vascular bed depends on the particular situation. The compensatory reflexes in the vasomotor center and pressor receptors in the carotid sinus and aortic arch act temporarily to compensate for the disproportion between blood volume and vascular capacity. However, in the event that it is not corrected, the situation becomes irreversible. The final result in the main is that of cerebral ischemia, coronary

ischemia or acute tubular necrosis (lower nephron nephrosis). The last we fear most, especially in the younger age group. The exact mechanism of acute tubular necrosis is not known. However, Oliver and associates [22] believe that destruction of the tubular basement membrane is caused by renal ischemia.

Of course the adrenal gland plays quite an important role in the physiology of shock. There are various causes of adrenal insufficiency. One of the frequently unrecognized causes is surgical shock. The predominant adrenocortical steroid, which is found in the human plasma, is 17-hydroxycorticosterone. There has been speculation as to exactly how this protects the normal cell in times of crisis. Experimental work infers that corticosteroids protect the cells, at the cell level, from antigen-antibody reactions in addition to bacterial and non-bacterial toxins. This may occur by altering cell metabolism, so that the cell is not susceptible to disease processes.

The replacement of blood in a person who is bleeding is a time-honored dictum. However, some persons who have received adequate blood replacement and oxygen, and are placed in the Trendelenburg position, continue to remain in shock. In these patients vasopressor drugs must be used. As a rule, we usually administer 4 mg. of arterenol (norepinephrine) per 500 ml. of an infusion fluid, preferably 5 per cent glucose in water. It may be necessary at times to add as much as 8 mg. per 500 ml. As a rule, the starting point is 15 drops per minute, and this is increased 5 drops per minute until the response is achieved. The maintenance dose is obtained by trial. The reduction in dosage is done in a stepwise manner, and in some cases it may take days before this drug can be discontinued.

In those patients who do not respond immediately to arterenol it has been our policy in the past year to add 100 mg. of 17-hydroxycorticosterone, or compound F, to this infusion [23]. It has also been our experience in several instances to note that compound F had a potentiating effect upon arterenol. We have also used aqueous adrenocortical extract and found that 50 ml. of this added to the infusion had a potentiating effect on arterenol. In addition to the potentiating effect of elevating the patient's blood pressure, compound F may protect the cell from the toxic effects of shock. However, the use of this drug is not without danger. It may cause convulsions by lowering the cerebral electroshock threshold, may cause excessive sodium retention and may inhibit endogenous adrenocorticotropic hormone (ACTH) excretion. With the use of 100 mg. of compound F given over an eight- to twelve-hour period functional insufficiency of the adrenal gland can occur, but the immediate benefit of the administered hydrocortisone outweighs the possible subsequent alteration in adrenal function. The physician should be aware of this possible functional insufficiency and be prepared to administer ACTH and corticosteroids as necessary.

SUMMARY

The etiologic factors in gastrointestinal hemorrhage are presented. A definite therapeutic regimen should be followed in every case of gastrointestinal hemorrhage: (1) supportive blood replacement therapy immediately, (2) early diagnosis utilizing laboratory and x-ray facilities, esophagoscopy and gastroscopy when available, (3) surgical intervention without delay when bleeding is uncontrollable by conservative methods, and (4) prevention of shock utilizing vasopressor drugs and adrenocortical hormones.

17-Hydroxycorticosterone (compound F) has a potentiating effect on arterenol and may be life saving when replacement therapy, oxygen, Trendelenburg position, and arterenol alone have no effect on shock.

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Bleeding in Colonic Diverticulitis

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SINCE the beginning of this century, diverticulitis of the colon has become a well recognized clinical and pathologic entity. More recently, its medical and surgical implications have been studied thoroughly and attempts have been made to establish the proper principles of management of this disease and its complications. Consequently, rather extensive information is available regarding the clinical and pathologic manifestations of acute diverticulitis, diverticulitis with perforation, diverticulitis with abscesses and diverticulitis with fistulas. Although hemorrhage in association with diverticulitis also has received considerable attention, information about this particular complication, especially regarding its pathogenesis, is not so nearly complete as might be desirable.

Throughout the past fifty years, authorities on this subject repeatedly have warned physicians to search diligently for causes other than diverticulitis when rectal bleeding occurs. This is still sound advice despite the fact that bleeding can occur from diverticulitis alone. The frequency with which such bleeding occurs in cases of diverticulitis has been reported to be from 3 to 47 per cent, but the majority of studies report a frequency of 10 to 30 per cent. The bleeding may be of any magnitude but is usually moderate in amount. The pathogenesis of bleeding directly attributable to diverticulitis has not been extensively investigated, although Noer [8], McGrath [7], Kocour [5], de Quervain [2], Young and Howorth [14], Lahey [6], Hoar and Bernhard [4], and Quinn and Ochsner [9] have made significant contributions. The bleeding usually has been attributed to ulceration of the colonic wall or to ulceration within a diverticulum, and in a few instances such lesions have been seen. Actually, detailed pathologic studies of sufficient magnitude to allow determination of the frequency of such findings have not been published. McGrath [7], in 1912, noted mucosal ulceration in eleven of twenty-seven surgical specimens, but he made no attempt to correlate this alteration with clinical findings. de Quervain [2] described a "hemorrhagic form" of diverticulitis, about which he made this statement: "The patient is distressed, at times, by fairly severe intestinal hemorrhage, which clearly arises from ulcerative erosion of small vessels in the diverticulum." It is impossible to determine whether or not de Quervain actually saw such ulceration, because pathologic studies were not included in his article.

Synnott [12] stated that bleeding in diverticulitis originated in "eroding ulcerations of the mucosa lining the diverticulum or in small polyps in the diverticular area and not in the mucosa of the colon itself." Again, corroborative pathologic studies were not presented. That ulceration within diverticula does account for some instances of bleeding was proved by Kocour [5], who reported a death caused by hemorrhage from an eroded artery in a diverticulum. Smith [11] reported the sigmoidoscopic visualization of several bleeding diverticula in a patient who had massive gastrointestinal hemorrhage.

Young and Howorth [14] reported a case of diverticulitis and bleeding in which the surgical specimen contained numerous diverticula, several of which were inverted into the intestinal lumen. Ulceration was present on the mucosa of one of these inverted diverticula and this was considered to be the source of hemorrhage. These observers were unable to find any mention of inversion of diverticula in the literature. It appeared to them that an inverted diverticu-

lum might bleed just as a polyp does when its surface becomes ulcerated. They pointed out that large vessels frequently are present about the bases of diverticula that might be the source of hemorrhage.

Rosser [10] and Boyd [1] suggested that bleeding may arise from granulation tissue in diverticula that are the site of inflammation. Hickey [3] reported an unusual case in which an abscess had perforated into the inferior epigastric artery, with severe hemorrhage.

Hoar and Bernhard [4] recently contributed valuable information regarding the pathologic findings in diverticulitis with bleeding. They found that forty-two of 111 patients with diverticulitis had rectal bleeding. They examined pathologic specimens from three of these patients. In one specimen, four of five diverticula sectioned showed engorged granulation tissue replacing part of the mucosa. Ulceration was present in several of the diverticula in another specimen. The source of bleeding was not discovered in their third case.

Of sixty-eight patients with diverticulitis and diverticulosis reported by Noer [8], twenty had bleeding as a presenting or major symptom. Six of these patients underwent resection and specimens were examined pathologically in all six; ulceration was found in one of the specimens.

Bleeding from diverticulitis may occur in the presence of one of the other complications of the disease, or it may be the only complication present. The amount of blood lost is usually small or moderate, but in a significant number of cases it has been excessive, even to the point of being termed "exsanguinating." Hoar and Bernhard [4] stated that most of the patients who have massive bleeding are more than sixty years of age and they frequently have arterial hypertension.

It is often difficult to establish a clinical diagnosis of "bleeding diverticulitis." Quinn and Ochsner [9] gave the following criteria that, when fulfilled, justify the assumption that the bleeding is from diverticulosis or diverticulitis: passage of gross blood per rectum; evidence of diverticulitis or diverticulosis after use of a barium enema; absence of other intrinsic lesions on rectal or proctoscopic examination; roentgenographic studies demonstrating the stomach and small intestine to be normal. Thus, it is apparent that the diagnosis is often by exclusion.

The management of this complication of diverticulitis usually has been conservative, consisting of measures designed to put the intestine at rest, the administration of antibiotics and whole blood when indicated, and general supportive therapy. For the most part, this regimen has been adequate and surgical intervention has been used in the past only in those cases in which other indications for operation were present or in which the bleeding could not be controlled by medical means. Recently, however, surgical resection of the affected portion of colon has been used more extensively in the treatment of recurrent, persistent or severe hemorrhage.

The present study was undertaken in an effort to correlate the pathologic features and the clinical manifestations of this complication of diverticulitis of the colon in the hope that such a correlation might contribute to better understanding and management of this disease.

PRESENT STUDY

The diagnosis of diverticulitis of the colon was recorded for 1,970 patients at the Mayo Clinic from 1940 to 1954, inclusive. Of these patients, 145 (7.4 per cent) gave histories of having passed blood by rectum for which no cause other than the diverticulitis could be found. Pathologic specimens preserved in formalin were available for examination in thirty-two of these 145 patients who had rectal bleeding. Thirty of these specimens were obtained during surgical resection of the affected colonic segments, whereas two specimens were obtained at necropsy.

The clinical records of these thirty-two patients were examined for pertinent data relating to age, sex, symptoms, physical and laboratory findings, treatment, clinical course and follow-up studies. The findings at operation or necropsy were noted.

The specimens were studied grossly with special reference to the appearance and thickness of the colonic mucosa, the presence or absence of ulceration, the diameter of the intestinal lumen, the thickness of the colonic wall, the presence or absence of zones of hemorrhage, the number of diverticula present, and the extent of diverticulitis. Multiple gross cross sections of the specimens were made for further examination of the areas of diverticulitis. Particular attention was paid to those regions in which extravasation of blood was

evident. Blocks of tissue for microscopic study were taken from any obvious regions of ulceration or hemorrhage. Additional blocks of tissue were taken from any suspicious portions encountered during examination.

Sections for microscopic examination were prepared and stained with hematoxylin and eosin in the usual manner. The original sections were available in ten of the thirty-two patients. All sections were studied to determine the characteristic picture present, and a search was made for any features that might account for the clinical bleeding.

Six specimens of colon removed surgically for diverticulitis or one of its complications other than bleeding were picked at random for control specimens. These were examined in exactly the same manner as were the aforementioned thirty-two specimens.

CLINICAL FINDINGS

Nineteen of the patients were men and thirteen were women. The range of age was from twenty-six to seventy-seven years, but only one patient was under forty. Five were in the fifth decade of life, thirteen were in the sixth decade and ten were in the seventh decade. Three patients were more than seventy years of age.

Gross blood had been passed from the rectum by all the patients. The bleeding was often intermittent, and the blood usually was bright red. Bleeding was mild in twelve patients, moderately severe in nineteen and severe in one. Hemorrhage was the symptom that led the patient to seek medical care in seven instances (22 per cent); bleeding was the only symptom noted in six of these instances. The duration of bleeding varied considerably. Seventeen of the patients had noted blood in the stools for less than three months, whereas five patients had experienced bleeding for three months or more but less than a year. Ten patients had noted bleeding for a year or more, three of this latter group having observed it for more than five years.

Rectal bleeding was overshadowed by other symptoms in twenty-five cases. In order of frequency, these were abdominal pain, chills, fever, diarrhea, decreased caliber of stools, constipation, dysuria and weakness. Although the presenting complaint was one other than bleeding, hemorrhage was recorded as being one of the major complaints in fifteen patients.

The most frequently noted physical findings and the number of cases in which each finding was encountered were abdominal tenderness (fifteen), extrarectal mass (nine), mass in the left lower abdominal quadrant (six) and intrarectal mass (two). Although most of the patients had physical findings suggestive of diverticulitis, the results of examinations were completely negative in seven patients (22 per cent).

Results of routine laboratory studies were within normal limits except for the patient who had massive bleeding and in whom the value for hemoglobin was less than 10 gm. per 100 ml. of blood.

Proctoscopic examinations were performed on twenty-nine patients. Diverticula were seen in seven patients, and the findings were suggestive, but not diagnostic, of diverticulitis in nine others. Bleeding zones were seen in the intestinal mucosa in two patients. In one patient, an erroneous diagnosis of carcinoma was made. Entirely negative results of proctoscopic examination were recorded for seven patients. The three remaining patients had pathologic proctoscopic findings unrelated to the rectal bleeding.

Roentgenologic examinations of the colon were done on thirty of the thirty-two patients. A definite diagnosis of diverticulitis was made in eighteen, and this diagnosis was suggested in four others. In the remaining eight patients, the radiologist considered a question of the presence of a neoplasm of the colon, but a definite roentgenologic diagnosis of carcinoma was reported in only one instance.

Surgical exploration was performed on thirty-one of the thirty-two patients. Although rectal bleeding was frequently a major consideration in the decision to perform laparotomy, in only one patient was the problem of bleeding the sole surgical indication. The possibility of the presence of a malignant lesion undoubtedly influenced the decision to operate in many of these patients. Other indications were the existence of obstruction, the presence of an abdominal mass, and pronounced severity, persistence or recurrence of the symptoms of acute diverticulitis.

Five different types of operative procedures were performed on the thirty-one patients just mentioned. Eleven underwent exteriorization procedures in which the affected loop of intes-

tine was brought out to the skin and subsequently excised, with extraperitoneal closure of the resulting colonic stoma as a final step. Primary resection with end-to-end anastomosis was performed in ten cases. Six patients underwent three-stage resection in which transversostomy preceded resection and anastomosis of the colon, the colonic stoma being closed later as a third stage. Three patients underwent primary resection and anastomosis with concomitant transversostomy and subsequent closure of the stoma. One patient underwent transversostomy but died before further surgical procedures could be performed. Except for this patient, all those treated surgically did well in the immediate postoperative period. Thrombophlebitis of the deep veins of one lower extremity developed in one patient but responded well to treatment. A fistula developed at the site of closure of the colonic stoma in another patient but later closed spontaneously.

Twenty-four of the surviving patients have been followed up postoperatively for periods up to ten years. What was described as an episode of "intestinal obstruction" developed in one patient several years after operation; he was hospitalized elsewhere and recovered with conservative management. The other twenty-three patients have had no further symptoms attributable to diverticulitis.

As previously indicated, two patients died. One died of peritonitis and bronchopneumonia after transversostomy. The other patient, who had massive rectal bleeding two weeks prior to admission, died of myocardial infarction.

PATHOLOGIC FINDINGS

The length of colon that was resected varied from 10 to 35 cm., the average being between 15 and 20 cm. The zone of diverticulitis was in the sigmoid colon in twenty-seven patients and in the descending colon in four. Multiple regions of involvement were scattered from the ascending colon to the sigmoid in one patient.

The pathologic findings generally were typical of those usually found in diverticulitis. Almost without exception there was segmental involvement characterized by pronounced edema of the pericolonic tissues, thickening of the muscular wall, engorgement of blood vessels and, in more than half of the specimens, narrowing of the intestinal lumen. For the most part, the inflammatory process appeared to involve small numbers of diverticula, even though multiple uninvolved diverticula might be present in other portions of the intestine.

Microscopically, the intestinal wall and pericolonic tissues were infiltrated with polymorphonuclear leukocytes and, to a lesser extent, with mononuclear cells. The tissues were edematous and increased fibrous tissue could be found in the older lesions. The muscular layers of the intestine were thickened in many instances, particularly in those specimens in which the lumen was narrowed. In half of the specimens the mucosa was in polypoid folds which were so striking at times that they gave the appearance of true polyps. However, close inspection revealed the true nature of the changes.

Because of our particular interest in bleeding, a careful search for any changes pertaining to this was made. Gross examination revealed definite ulceration of the colonic mucosa in three specimens. Nineteen of the specimens had discolored zones in the mucosa suggestive of hemorrhage. Early in the gross study it was found that many areas of hemorrhage could be discovered by inspection of the colonic walls and the pericolonic regions. This proved to be one of the best methods of locating tissues from which bleeding might have originated. In eleven specimens, diverticula could be traced into, and grossly appeared to constitute a part of, these hemorrhagic regions. An ulcerated inverted diverticulum was present in one specimen.

Microscopic studies disclosed ulceration of the surface colonic mucosa in five other specimens in addition to the aforementioned three specimens in which ulceration was visible grossly. Microscopically, these ulcerated zones proved to be typical inflammatory ulcers characterized by absence of surface epithelium, destruction of the submucosa, vascular engorgement and evidence of acute inflammation. (Fig. 1.) The ulceration in each of these eight instances was considered sufficient to produce bleeding, and good evidence of such bleeding was demonstrated in one section.

Ulceration of the mucosa buried deeply in one or more diverticula was demonstrated microscopically in ten specimens. The microscopic picture of these ulcers was the same as that found in ulceration affecting the regular

FIG. 1. Colonic wall in diverticulitis with bleeding, demonstrating ulceration of the colonic mucosa. Note depth of penetration and the inflammatory reaction. Hematoxylin and eosin stain, original magnification × 18.

mucosa. Completely disrupted diverticula were seen in some sections, while less extensive ulceration was present in other specimens. (Figs. 2 and 3.) In two instances in which microscopic ulceration of the colonic mucosa was found, additional ulceration within diverticula was present. In eight of the eleven specimens in which diverticula could be traced into regions of gross hemorrhage, microscopic examination revealed ulceration of the walls of the diverticula into the surrounding inflammatory hemorrhagic tissues. The extent of vascular engorgement in the inflamed tissues left little doubt that these ulcerated zones might be the source of significant bleeding.

Thus, the gross and microscopic findings disclosed that eighteen (56 per cent) of these thirty-two patients had ulceration either of the colonic wall or within diverticula.

Similar studies of the control group of six specimens disclosed little difference in the over-all pathologic picture between the two groups of specimens. Absent in the control group, however, was evidence of hemorrhage or areas that might serve as sources of hemorrhage. Gross ulceration of the mucosa was absent, and microscopic examination failed to reveal any ulceration of the colonic wall or within diverticula.

COMMENTS

It appears reasonable to assume that the origin of the bleeding in patients who have diverticulitis of the colon is from ulceration somewhere in the affected intestine, which is usually the sigmoid colon. This is borne out by the findings in the present study. In more than half of the specimens ulceration was noted in the colon or within diverticula. Other writers [*4,8*], have seen such ulceration in the intestines of patients who have bled from diverticulitis.

It is assumed that such ulceration arises as a direct result of inflammation. It is possible that the trauma of the fecal current may contribute to the ulceration, but it appears that edema, exudation and necrosis of tissue could cause the ulceration within diverticula and that in the intestinal mucosa as well. It is not difficult to understand that bleeding may occur from a zone of diverticulitis that becomes ulcerated, especially in view of the pronounced vascular engorgement occurring within tissues affected by diverticulitis. One might wonder why bleeding does not occur more frequently.

It is likely that many regions of ulceration were missed in the present study, because the method of gross serial sectioning employed was somewhat inadequate at best. Microscopic serial sectioning could be expected to increase the positive findings to a figure much nearer 100 per cent than that reported herein.

As already noted, one of our specimens contained an ulcerated inverted diverticulum. The possibility of this rare condition should be emphasized because of the danger of mistaking such a lesion for a polyp at proctoscopic examination. Cauterization or biopsy under such circumstances could produce serious consequences.

The frequency with which diverticula could be traced into zones of gross hemorrhage and the microscopic demonstration of ulceration in these regions proved to be among the most interesting aspects of the present study. This occurred eleven times, and the microscopic findings were positive in eight cases. This would appear to be of significance, and it is possible that close attention to the involved segments of colon removed surgically in patients with clinical bleeding might reveal the source of bleeding in many instances.

It might be well to re-emphasize the fact that a neoplasm of the colon is the cause of bleeding from the rectum far more frequently than is diverticulitis. Welch and associates [*13*] estimated that carcinoma of the colon is the cause of rectal bleeding five times as frequently as is diverticulitis. The presence of diverticu-

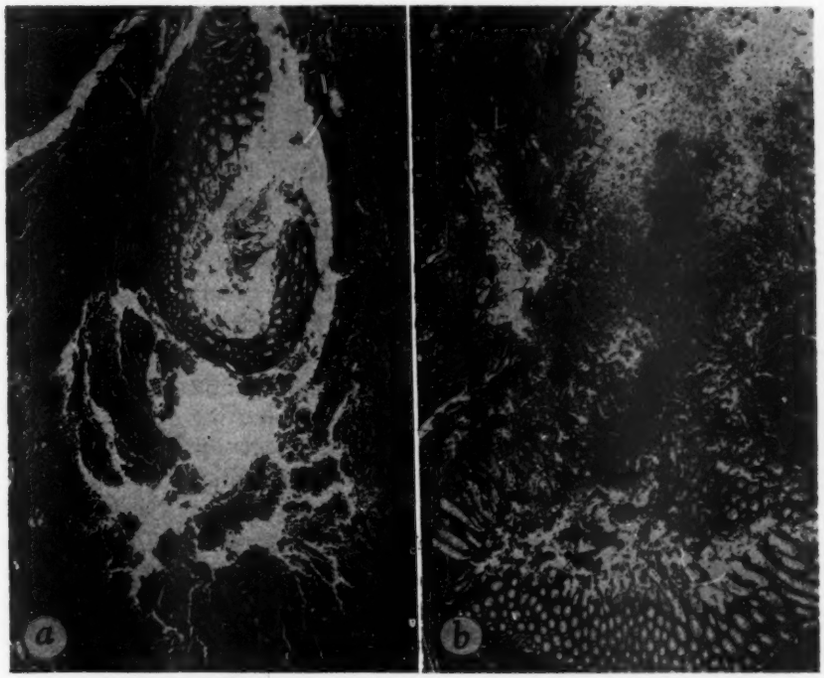

FIG. 2. (*a*) and (*b*), Two examples of ulceration within a diverticulum in diverticulitis with bleeding. Hematoxylin and eosin stains, original magnification × 16.

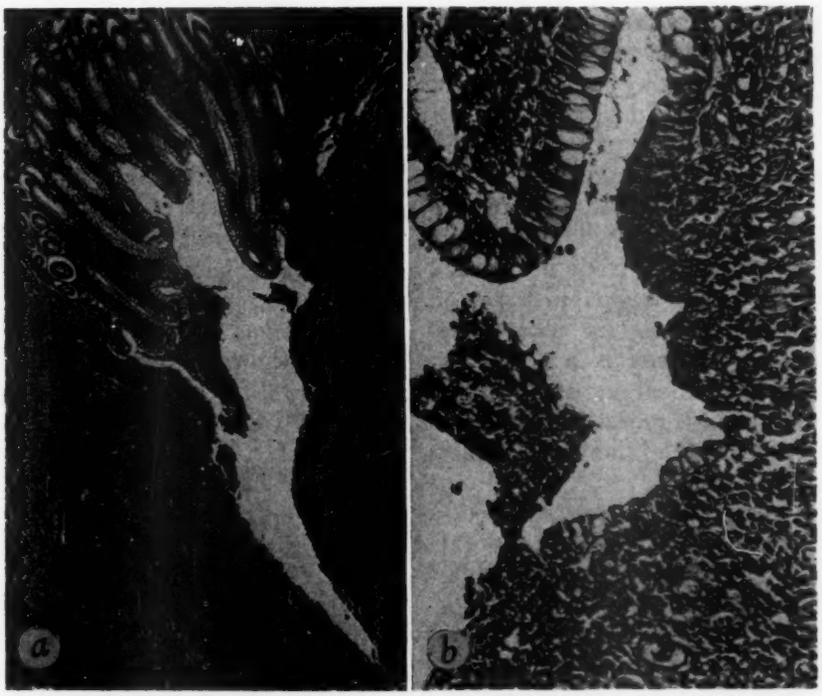

FIG. 3. (*a*), Diverticulum with ulceration in diverticulitis with bleeding. Hematoxylin and eosin stain, original magnification × 16. (*b*), Wall of diverticulum shown in (*a*). Note ulceration and surrounding inflammatory reaction. Hematoxylin and eosin stain, original magnification × 170.

litis does not give any assurance that a concomitant carcinoma is not present. The aforementioned total of 1,970 patients surveyed in the present study included 100 patients who had simultaneous diverticulitis and carcinoma.

Carcinoma of the colon has received emphasis as the principal disease to be differentiated from diverticulitis in patients who have rectal bleeding, and it is probably the most important one. However, other diseases of the anal canal and colon must be considered in dealing with these patients. External and internal hemorrhoids, fissures, adenomatous polyps and ulcerative colitis are all capable of causing rectal bleeding. In addition, lesions of the upper part of the gastrointestinal tract, such as peptic ulcer, gastric neoplasm, Meckel's diverticulum and neoplasms of the small intestine, may produce bleeding that is difficult to differentiate from colonic bleeding. All these conditions must be considered before a diagnosis of diverticulitis with bleeding is made. The differentiation of these conditions frequently cannot be made until the time of operation, and occasionally the correct diagnosis cannot be made even then.

The bleeding from diverticulitis characteristically is associated with other symptoms of diverticulitis, and a history of intermittent attacks may be obtained. However, 19 per cent of our thirty-two patients had bleeding as the only symptom. The bleeding usually is small or moderate in amount, but instances of massive bleeding have been recorded, as occurred in one of the patients in this study. The bleeding was often recurrent or intermittent in character. One-third of the patients gave histories of recurrent attacks of bleeding for more than one year. The bleeding often is a relatively minor symptom in the clinical picture, and the major complaints are those more characteristic of diverticulitis, such as abdominal pain, chills, fever, dysuria and diarrhea.

Although the physical findings usually associated with diverticulitis may be present, the general examination may not be helpful insofar as the differential diagnosis of rectal bleeding is concerned, and sometimes the results of physical examination may be entirely normal.

Proctoscopic and roentgenologic examinations have proved valuable in the study of these patients. About half of the patients who underwent proctoscopic examinations had findings either diagnostic of or suggestive of diverticulitis. A definite roentgenologic diagnosis of diverticulitis was made in 60 per cent of the patients so examined. As useful as these examinations may be, it must be remembered that they are not infallible and that the presence of diverticulitis does not exclude the possibility of other disease.

The management of patients who have "bleeding diverticulitis" usually has been conservative in the past. Such management appears reasonable for patients in whom the diagnosis can be definitely established and who exhibit bleeding for the first time. However, recurrent hemorrhage is not infrequent, and it is often impossible to exclude the possibility of malignant lesions. In these instances, it would be wiser to employ surgical therapy. Bleeding rarely is the only indication for surgical intervention in these patients; only one patient in the present study had bleeding as the sole surgical indication. Some other complication of diverticulitis or doubt as to the nature of the pathologic process usually dictates the surgical approach. Generally speaking, indications for laparotomy in diverticulitis have been, and are, increasing. Indications for operation in "bleeding diverticulitis" probably will follow the same pattern.

The surgical procedures performed for the patients in this study were predominantly multiple-stage resections, which have proved to be an adequate method of management, particularly for the extremely ill patient. Because of improved operative technics, better anesthesia, use of chemotherapeutic and antibiotic agents, and more efficient preoperative and postoperative care, primary resection of the colon recently has been used more frequently. The role of primary resection may increase in scope as surgical technics advance, but some patients still will require multiple-stage operations because of debility, extensive local disease or technical factors. The surgical procedure necessary in a given case is probably best decided in the operating room, where the extent of the disease can be evaluated.

The final results of surgical therapy in the present group of patients have been satisfactory, although it is difficult to draw any extensive conclusions from such a small group. One patient died after transversostomy, death being due to perforation of the colon and peritonitis. The other patients who have been adequately

followed up have done well except for minor complications.

SUMMARY AND CONCLUSIONS

Detailed pathologic, clinical and follow-up studies have been made on thirty-one patients who underwent surgical treatment at the Mayo Clinic for colonic diverticulitis associated with bleeding and on one patient who died from myocardial infarction two weeks after massive rectal bleeding accompanying diverticulitis.

Hemorrhage is a proved complication of diverticulitis. Although it is relatively rare, it must be considered in the differential diagnosis of rectal bleeding. The bleeding arises from ulceration of the affected colonic wall or ulceration within one or more diverticula.

The bleeding is usually small or moderate in amount, is frequently recurrent over long periods and is usually associated with other symptoms of diverticulitis. It is difficult to differentiate bleeding due to diverticulitis from that due to neoplasm, and both diseases may occur simultaneously.

The physical findings in "bleeding diverticulitis" are not characteristic. Roentgenologic and proctoscopic examinations are helpful in establishing a diagnosis, but neither should be considered infallible.

In patients with diverticulitis, the complication of hemorrhage can be treated conservatively in many instances, provided that no doubt exists concerning the diagnosis.

Surgical resection of the affected colon is justified in patients who have recurrent or uncontrollable hemorrhage, in those in whom the presence of a neoplasm cannot be excluded and in those who have indications for operation other than hemorrhage.

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Preservation of the Pyloric Antrum in Resection of High Gastric Malignancies

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DURING an operation one is frequently faced with circumstances in which consideration of operative technic calls for an extension of the resection beyond that required purely on the basis of the pathologic-anatomic findings. Such a situation is exemplified by the right-sided hemicolectomy which is undertaken as a rule even in the treatment of inflammatory conditions when removal of the terminal ileum and ascending colon would satisfy the requisites of radicality. Due to the unreliability of sutures in a segment of intestine free of serosa, such as the partially retroperitoneal ascending colon, it becomes necessary to include in the resection both the ascending and part of the transverse colon. Similar considerations apparently justify the widespread use of total gastrectomy in the treatment of upper gastric malignancies. Although the extent of infiltrative growth would permit the antrum to be retained, it is believed that for the benefit of simplifying the procedure the resection should extend into the upper part of the duodenum, continuity being then established by closing the duodenal stump and performing esophagojejunostomy, or simply by esophagoduodenostomy.

This unnecessary sacrifice of the antrum is carried out for two reasons. One of these is based on the views propagated particularly by Lahey that late results in radically treated gastric malignancies could be improved by total gastrectomy. Impetus for this view was supplied by Lahey's data in which one-third of the patients subjected to subtotal resection evidenced a relapse within the gastric stump. Aside from the fact that these particular findings have not been confirmed by other authors, one must realize that in treating a carcinoma of the fundus we are faced by an entirely different problem. The relapses in the proximal gastric stump mentioned previously represent a spread of the tumor within the submucosa and toward the cardia which cannot be recognized during the operation. On the other hand, in treating a fundic carcinoma, it remains to be shown that cutting the stomach through a line passing some 10 cm. distal from the visible and/or palpable border of the tumor still falls within a region in which a submucous carcinomatous lymphangitis is present. In our patients in whom the antrum was retained, but in whom death occurred either as a result of a relapse or widespread metastasis, autopsy has not revealed the presence of tumor in the remaining section of the antrum.

Marshall, in reviewing Lahey's case histories, was unable to establish an improvement in late results when total gastrectomy was used as the method of choice for treating gastric carcinoma. Thus a view which has been advocated by other authors and ourselves has gained additional support.

The second reason is provided by evidence which emphasizes the irrelevancy of whether or not the antrum is sacrificed. According to this standpoint little functional significance is attached to the prepyloric segment, a part where the pyloric glands are known to produce a mucinous alkaline fluid designed to neutralize the acid gastric secretions. The antrum, as is well known, provides an added stimulus to acid production by liberating a hormone-like substance which stimulates the acid-producing cells. We must grant that these functions have little meaning once both the corpus and fundus have been removed so that, based at least on evidence from experimental work, sacrifice of the antrum cannot be regarded as being too significant. However it is likely that our knowledge regarding the functional significance of this particular gastric sector has not been exhausted and, as the work of Holle and

Heinrich has demonstrated, the prepyloric region contributes considerably more to the digestive process than has been attributed to it purely on an experimental basis.

Prompted by our inability to correct a number of disturbances in the digestion of fat and protein following total gastrectomy we have been proposing preservation of the antrum and have carried it out since 1944 in the treatment of two types of lesions. A detailed report of this work was published in 1950. The lesions referred to are: (1) those penetrating ulcers of the upper gastric region in which participation of both anterior and posterior walls in the perifocal scar prevents construction of an adequate tube from the remaining segment of the great curvature and (2) fundic carcinoma. In the latter instance end-to-end anastomosis between esophagus and antrum was performed. This method was originally suggested by Borchers in 1928, however, with a resection which was somewhat less extensive.

The disadvantage of a direct anastomosis between the esophageal stump and the prepyloric segment is twofold: first, these two parts differ widely in their cross sectional area; and second, one frequently finds it difficult to mobilize both the antrum and duodenum adequately so as to obtain an anastomosis that is free of tension. When the disadvantages of an esophagoantrostomy became evident, in several patients the antrum stump was closed blindly, continuity being re-established by means of an esophagojejunostomy. Although pyloromyotomy was undertaken regularly, several patients complained of a feeling of pressure in the right epigastrium.

Interesting in this respect is the history of a patient operated upon seven years ago for a small carcinoma of the fundus and whom we have recently had the opportunity to re-examine. This patient had complained of periodic, colic-like pains in the right epigastrium that were suspected of being caused by biliary stones despite a negative cholecystogram. One might assume that in this case the difficulties were due to a pylorospasm which prevented the adequate emptying of secretions accumulated in the antrum.

All patients in whom the antrum had been retained in the described manner complained of digestive disturbances similar in nature to those usually following total gastrectomy. This lead us to assume that once incorporation of the antrum into the intestinal continuity is re-established, it may provide an opportunity for regaining certain physiologic functions. Passage of even small quantities of food through the duodenum would allow for additional stimulation of bile and pancreatic flow.

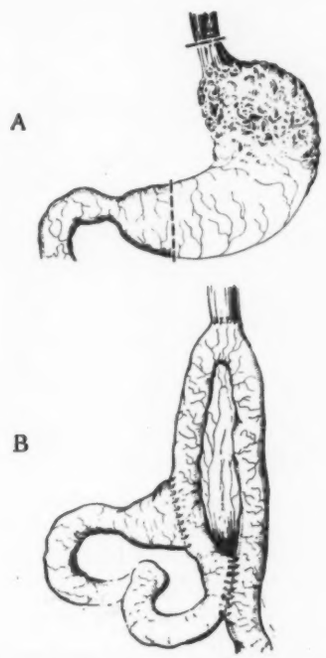

FIG. 1. A, schematic outline of location of gastric malignancy; extent of resection (dotted line). B, the three anastomoses for re-establishing the foodway (with preservation of the pyloric antrum).

With these considerations in mind continuity was re-established by end-to-side anastomosis between the antrum stump and the convolute leading to the esophagojejunostomy, with an additional enteroanastomosis distal to this point. (Figs. 1 and 2.)

In 1950 Zacho independently published a similar method for preserving and incorporating the antrum, and reported one case. This paper, which appeared in a Danish journal, was unknown to us at the time of our first report in 1954. The latter represented an accumulation of clinical data and attempted to indicate that the described procedure could partially reduce the frequency of metabolic disturbances following gastrectomy.

In the interim, work by Holle and Heinrich on patients operated upon has confirmed our earlier clinical observations. These authors concluded that the retained segment of the stomach could still produce sufficient amounts of

FIG. 2. Roentgenogram of a patient following preservation of pyloric antrum in high gastric malignancy. Part of the barium passes through the antrum and duodenum which are well outlined.

acid for the activation of pepsin and the reduction of iron as well as adequate quantities of indispensable mucoproteins. On the other hand, these authors emphasized that following total gastrectomy one finds with greater frequency disturbances in the anterohepatic metabolism of proteins, the reabsorption of iron and erythrogenesis. An increased bacterial flora within the bile ducts and subsequent degeneration of liver parenchyma was also a frequent sequel to this procedure. Thus, fundectomy appears to provide a situation which, at least in respect to protein and iron metabolism, can be considered as being favorable.

Radiologic studies by Rossetti in the Basel Clinic have additionally established that passage of the ingesta still takes place through the retained portions of the antrum.

We have finally come to apply these same principles following transthoracic resection of the cardia by anastomosing in a similar manner the remaining part of the stomach to the jejunum. In order to insure passage of food through the duodenum following total gastrectomy we have implanted the duodenal stump into the loop used for the esophagojejunostomy.

In the period from April 1, 1952 to October 1, 1955, seventeen patients were operated upon in the Basel Clinic for carcinoma of the upper gastric region by retaining the antrum as described previously. There were no deaths due to operation.

One patient, a seventy-two year old man whose postoperative condition appeared particularly unusual in that it contradicted the intrinsic worth of the described procedure, died after a two-month stay in the clinic. The operation consisted of a transthoracic approach for removal of a carcinoma of the cardia that had extensively infiltrated the fundus. Following resection of the lower esophagus, corpus and fundus, the remaining antrum was implanted into the already established esophagojejunostomy. The immediate postoperative recovery was uneventful. Soon after, however, severe aplastic anemia developed for which no basis could be established. Radiologically, the anastomosis appeared to function well and no signs of esophagitis or gastritis could be noted. Despite repeated blood transfusions, the plasma proteins remained below their normal value. An answer was finally provided by autopsy which revealed an extensive skeletal metastasis. Thus the changes in the blood picture were not due to a malfunctioning anastomosis but to the destructive growth of the malignancy.

In conclusion, our observations would seem to indicate that a procedure whereby the antrum is not only retained but also included into the intestinal continuity is a desirable procedure for the treatment of carcinoma of the fundus. By this approach the occasionally irreversible nutritional difficulties encountered after total gastrectomy can, for practical purposes, be eliminated.

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The Use of Muscle Relaxants in Anesthesiology. By Frances F. Foldes, M.D. (Director, Department of Anesthesia, Mercy Hospital; Associate Professor of Anesthesiology, University of Pittsburgh, School of Medicine, Pittsburgh, Pa.). Illustrated by Margaret M. Croup. 210 pages, with references and author and subject indexes. Springfield, Ill., 1957. Charles C Thomas. *Price* $5.50.

General Urology. By Donald R. Smith, M.D. (Clinical Professor of Urology and Chairman of the Department of Urology, University of California School of Medicine, San Francisco, Calif.). Illustrated by Ralph Sweet. 328 pages, many illustrations (above average); bibliography at chapter endings, with an index. Los Altos, 1957. Lange Medical Publications. *Price* $4.50. (Modest cost because the cover is not cloth.)

Calcified Tendinitis of the Shoulder

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ACUTE calcified tendinitis is the most painful condition of the shoulder. Calcium deposits are found more frequently in the rotator tendons of the shoulder than in any other tendons of the body. A calcified deposit may remain quiescent or asymptomatic for months or years and then suddenly become the center of an acute inflammatory process causing severe pain. Bosworth [1] stated that every large calcium deposit eventually causes symptoms. Although a few patients may recover without any treatment, most of the patients, especially those with acute symptoms, are in such misery that immediate effective treatment is necessary. Calcified deposits in the shoulder are still being treated by a variety of methods. This report is an analysis of the results of treatment of seventy-five patients with painful calcified tendinitis of the shoulder.

Incidence. In a series of 228 patients with pain in the shoulder originating in the rotator cuff there were seventy-five patients with calcium deposits. Eight of the patients had bilateral involvement, making a total of eighty-three shoulders with calcified tendinitis or an incidence of 33 per cent of the total number of patients with painful shoulders. There were forty-two men and thirty-three women. The right side was involved in fifty-one cases and the left in thirty-two. The largest number of patients were in the fourth and fifth decades of life. The youngest patient was twenty-seven years of age, and the oldest sixty-nine. (Table 1.)

Most of the women were housewives; a few were secretaries and factory workers. The men were predominantly laborers and factory workers; only twelve were businessmen or white-collar workers.

Etiology and Pathology. The cause of the formation of the calcium deposit is obscure. It is apparently not due to any generalized metabolic disturbance or infection. Blood calcium studies made on several patients all gave normal results. Trauma has been implicated as a causative factor. In our series only ten of the seventy-five patients gave a history of any injury at all which could be related to the onset of symptoms. Although an injury such as a fall or direct blow may occasionally precipitate an acute attack in the shoulder with a "quiescent" calcium deposit, in most instances there is no history of any definite trauma. Apparently the cause is not any sudden trauma, but rather constant wear and tear which produces degenerative changes, loss of vascularity and deposition of amorphous calcium in the rotator tendons [2]. With every motion of the shoulder these tendons are constantly being pinched between the humerus and the coracoacromial arch. As a person ages, the tendons undergo degenerative changes which favor the formation of calcium deposits. According to Wells [3] the oxidation in necrotic tissue is at a minimum due to poor circulation. This causes a reduction in the carbon dioxide content of the tissue, and as a result there is an increased alkaline reaction which causes precipitation of calcium salts in the necrotic area. Conversely, should the calcium deposit arouse an inflammatory process around it, the resulting hyperemia and increased vascularity increase the oxidation and carbon dioxide in the tissue,

TABLE 1
AGE AND NUMBER OF PATIENTS WITH CALCIFIED TENDINITIS OF THE SHOULDER

Age (yr.)	No. Patients
27–29	2
30–39	22
40–49	32
50–59	11
60–69	8

changing the reaction from alkaline to acid and causing absorption of the calcium deposit.

Symptoms. Seventy-five per cent of the patients were first seen with an acutely painful shoulder of only a few days' duration. Many had had the acute pain only one or two days. Forty-five per cent of the patients had had some pain in the shoulder for three months or more before the present acute attack. In the acute stage the pain was quite severe and was frequently described as "sore as a boil" or "throbbing like a toothache." The slightest motion of the arm was extremely painful. Any sudden jar of the arm or even of the body would set off a paroxysm of acute pain. The painful extremity was held at the side, supported by the other hand. The patient readily localized the pain to an area on the anterior or lateral aspect of the shoulder which was extremely tender even to the slightest pressure. The pain was worse at night, frequently causing patients to lose sleep or to pace the floor throughout the night. The patient had an anxious, haggard expression; in many cases the diagnosis was made merely by looking at him.

Roentgenographic Findings. The calcium deposit appeared on the roentgenogram as a round, oval or multilocular shadow (Fig. 1) which was usually located in the anterosuperior region of the shoulder just above the tuberosity or under the acromion. In patients with acutely painful shoulders the deposit appeared as a well defined, flocculent and at times multilocular shadow (Fig. 2A), while in those with chronic symptoms the deposit was more dense, irregular and ill defined. In some patients a large calcium deposit appeared on the roentgenogram taken with the arm in external rotation (Fig. 2A), whereas no calcification at all was seen on the roentgenogram taken with the arm in internal rotation. (Fig. 2B.) Most of the calcium deposits measured 1.0 to 1.5 cm. in greatest dimension. Calcium deposits measuring 2 cm. or more were found in twenty-seven shoulders, the largest deposit being 4.0 by 1.0 cm. The size of the deposit was not always an indication of the severity of the pain. There were several patients with smaller deposits measuring between .5 and 1.0 cm. who had just as much acute pain as those patients with larger lesions.

Operative Findings. The following observations are based upon the findings in fifteen patients. Surgery was performed upon a total of twenty shoulders. The calcified lesion was found in the supraspinatus tendon in the majority of patients undergoing operation, and much less frequently in the other rotator cuff tendons. At times it was quite difficult to localize the deposit to a specific tendon. In most of these shoulders the subdeltoid bursa showed some signs of acute inflammation. The walls of the bursal sac were slightly thickened and the bursal cavity contained thin, fibrous adhesions. The majority of the shoulders operated upon showed calcified deposits in the acute stage. This appeared as a yellowish white elevation in the tendon under the bursa. Surrounding this was an area of hyperemia and edema very much resembling a boil. When the lesion was incised, a yellowish white material resembling tooth paste escaped under pressure. In some cases, under the soft center of the deposit chalk-like or gritty material was found embedded in the tendon substance. In none of the shoulders was any gross tear or rupture found in the rotator tendons. It would seem that the presence of a calcified deposit usually precluded the existence of any rupture or tear in the rotator cuff [4].

FIG. 1. Large "acute" calcium deposit in supraspinatus tendon.

TREATMENT

Most of the patients had had no previous treatment except for sedation. A few had been treated elsewhere with heat and diathermy. Fifteen of the seventy-five patients had x-ray therapy ranging from a few to several treatments either recently or some time prior without any relief from the acute pain. Two of the largest deposits removed surgically were from

FIG. 2A. Calcium deposit conspicuous in roentgenogram taken with shoulder in external rotation.

FIG. 2B. Same shoulder as Figure 2A. Deposit not seen in view taken with shoulder in internal rotation.

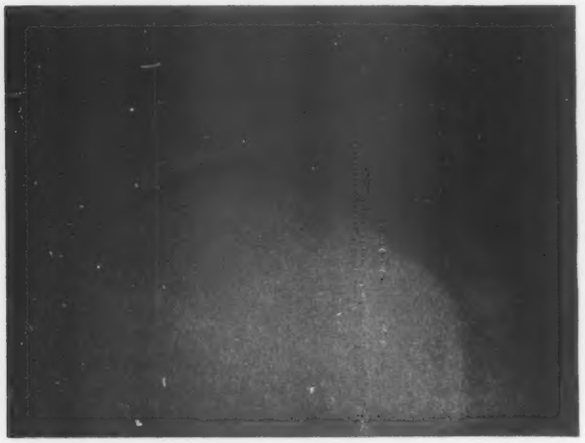

FIG. 3A. "Acute" calcium deposit before needling.

FIG. 3B. Complete disappearance of calcium deposit shown in Figure 3A, several days after needling.

patients who had had x-ray treatments. Comparison of roentgenograms taken some time prior to x-ray therapy with those taken recently showed no change in the size of the calcium deposit in most cases [5].

The patients in this series were treated by one of two methods or both. Most of the patients were treated by needling the deposit after infiltration with novocain.® In those patients who failed to get relief from this method of treatment the calcium deposit was excised surgically. The needling method consisted of infiltrating the calcified deposit with 1 per cent novocain, then piercing the deposit with a needle and attempting to aspirate or irrigate the calcium through a second needle according to the method of Patterson and Darrach [6]. A few patients with acute pain refused this method of treatment and chose to have the deposit excised. Sixty-five of the seventy-five patients treated by the infiltration or needling method were available for follow-up study (a total of seventy shoulders). In twenty-eight of the patients hydrocortone® was injected after needling the deposit. Needling was successful in relieving the pain in 85 per cent of the shoulders thus treated. In eight patients (a total of eleven shoulders) this method failed to relieve the acute pain. In most of the shoulders which were needled only part or a small amount of the calcium was aspirated or irrigated. In twelve shoulders no calcium at all could be removed. Nevertheless, most patients were relieved of the acute pain in one or two days after the needling. It was believed that the actual amount of calcium removed was not important, but rather, that the needling was effective in piercing the calcium deposit, relieving the tension and allowing the material to escape into the bursa where it could be ab-

FIG. 4A. Acute calcium deposit before needling.

FIG. 4B. Same shoulder as in Figure 4A, showing thinning out and spreading of calcified material into subdeltoid bursa after needling.

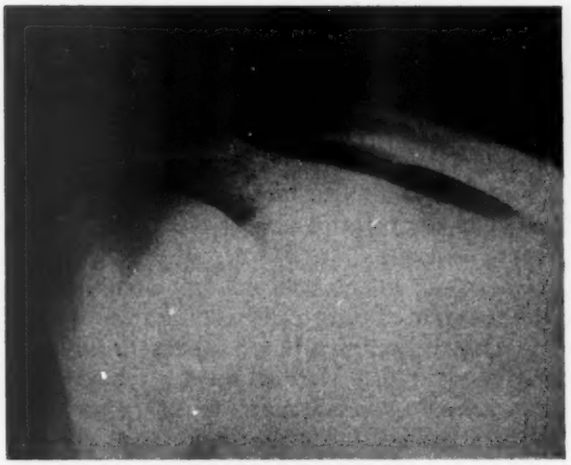

FIG. 5A. "Chronic" painful calcium deposit three years after three series of deep x-ray treatments.

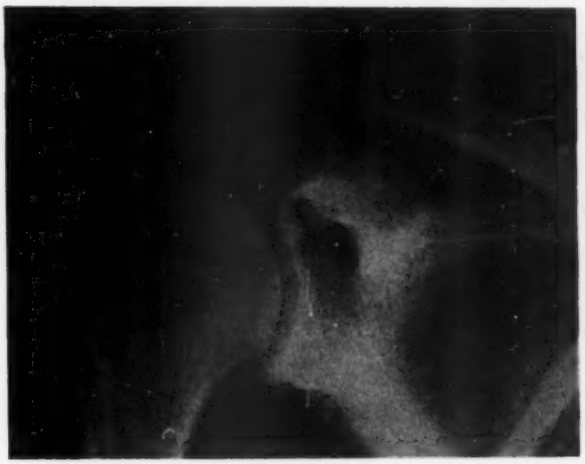

FIG. 5B. Same shoulder as in Figure 5A, after surgical excision of calcium deposit.

sorbed. Aspiration or irrigation of the calcium through the needle proved that the deposit had been punctured. In most of the patients in whom the pain was not relieved by needling, the deposit was quite large and no calcium was removed by aspiration or irrigation.

The needling procedure was usually done in the office and the patient was sent home immediately afterward. He was instructed to apply ice packs to the shoulder for twenty-four hours. We found that cold was an invaluable aid in lessening the amount of pain after the effects of the novocain ceased. Codeine and sedation were also prescribed. Gentle exercises were started the following day and gradually increased. Several patients were also treated with heat and diathermy after the needling procedure. In the successfully treated patients the acute pain was relieved in one or two days after needling, and within five or six days most of the pain had disappeared. Recovery of motion was fairly rapid. Eighty per cent of these patients regained 150 degrees of abduction within two or three weeks after the deposit was needled.

Although only a part of the calcareous material was aspirated in most of the cases, it was interesting to see what happened to the calcium deposit as shown on subsequent roentgenograms. In a few cases we were able to see the deposit practically disappear within several days after needling. (Fig. 3A and B.) In others the deposit appeared to have spread and thinned out, indicating that it had ruptured into the bursal cavity. (Fig. 4A and B.) In many of the cases roentgenograms taken within two to six weeks after the needling showed that 50 to 100 per cent of the deposit had disappeared. In contrast to this, in patients treated with x-ray therapy the deposit remained the same size for months or years after x-ray treatment. (Fig. 5A and B.)

Effect of Hydrocortone Injection. Patients who had hydrocortone injected into the calcium deposit at the time of needling seemed to have less pain after the anesthetic effect of novocain ceased. These patients also seemed to recover motion somewhat more rapidly than those who had not been injected with hydrocortone. However, we noted that in those shoulders in which the deposit was definitely pierced or aspirated, and where roentgenograms showed marked reduction in size of the calcium, the results were just as good whether or not hydrocortone had been used. It would seem, therefore, that decompression of the deposit is far more important than the local effect of hydrocortone. This drug did not appear to have any effect on the reduction in size or rapidity of disappearance of the calcium deposit.

Operative Treatment. In fifteen patients (a total of twenty shoulders) the calcium deposit was removed surgically. Practically all the patients in whom the deposit was removed surgically had had acute pain a few days to two weeks prior to surgery. Seventy-five per cent of those who underwent surgery had had some pain in the shoulder for over three months. In twelve of the shoulders there were deposits measuring over 2 cm., and five of these measured 3 cm. In eight of these patients (a total of eleven shoulders) infiltration and needling had failed to relieve the acute symptoms.

The operation is performed through a 2 inch longitudinal incision on the anterolateral aspect of the shoulder just anterior to the acromion. The deltoid fibers are separated, the bursa incised and the rotator cuff exposed. The arm is rotated until the deposit comes into view. The deposit is removed by incising its center, allowing the material to escape. If there is any dry or gritty calcium material in the tendon, it is removed with a curet. An ice pack is placed over the shoulder for a period of twenty-four hours after surgery. The pain is controlled with narcotics. Gentle exercises are instituted on the second or third day after surgery.

In almost all the patients who underwent operation the acute pain was relieved within one or two days after surgery. In a few shoulders the pain was not relieved until four or five days later and the patients had more than the usual amount of discomfort for two or four weeks. In one patient a frozen shoulder developed which did not regain full motion until after four months of extensive physical therapy. Recovery of motion was somewhat slower when surgery was performed. Examination of the twenty shoulders three weeks after surgery showed a range of abduction of 90 to 110 degrees in fourteen (70 per cent), 150 degrees in two, and 60 degrees or less in four. In the non-operated group 90 per cent of the patients had recovered more than 150 degrees of abduction in three weeks or less. The average time for recovery of full motion in the operated group was approximately two and a half months. It should be emphasized, of course, that in most instances the operated patients had had acute pain and limitation of motion for a longer time than the non-operated patients. Follow-up x-rays of the operated patients showed complete disappearance of the deposit except for a small speck which caused no symptoms. In general, surgical excision seemed to be more certain and the better method of treatment for the larger deposits (over 1.5 cm.) and for the chronic deposits.

Recurrence of Symptoms. In none of the patients treated surgically did the pain recur once it had completely disappeared. In only one patient did the deposit recur after needling and complete disappearance as shown on roentgenograms. This patient, a thirty-five year old housewife (A. G.), had been entirely relieved of pain and the deposit had completely disappeared, as shown on roentgenograms taken two weeks after needling. Four years later she returned with acute pain in the same shoulder. Roentgenograms then revealed a new deposit in another part of the rotator cuff. The acute pain was immediately relieved by needling and injection with hydrocortone, and the deposit again disappeared completely. Another patient (C. V. P.), a thirty year old man, returned with the complaint of acute pain in the shoulder six months after needling and aspiration had removed much of the deposit and had relieved the pain. Roentgenograms revealed the presence of a much smaller deposit in the same location. Complete relief was obtained by needling.

CONCLUSIONS

1. Calcium deposits are found in 33 per cent of patients with lesions in the rotator cuff of the shoulder. The deposits are found most

frequently in patients between thirty and fifty years of age.

2. Degeneration and avascular necrosis from wear and tear of the rotator cuff are apparently the most important factors in formation of the calcareous deposits.

3. The deposit may remain quiescent for months or years, but in the acute stage it may produce more pain than any other lesion in the shoulder. The acute pain subsides when the deposit ruptures into the bursal sac but usually the pain is so severe as to require immediate treatment.

4. In the majority of patients the acute episode is relieved by infiltration and piercing of the deposit, with rapid recovery of function. In patients with chronic or large lesions surgical excision is the treatment of choice.

5. Once the deposit has disappeared completely, recurrence of symptoms is rare. Peri-arthritis or frozen shoulder rarely develops in patients treated by needling or surgical excision.

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An End Result Study of Patellectomy

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Patellectomy is indicated for a varied number of lesions of the patella and patellofemoral articulation. We have performed patellectomy for many of these lesions and will report herein the end results of a study of fifty-eight such operations in fifty-five patients.

The operation is performed through a long, vertical incision over the patella with or without the use of a tourniquet. The incision is carried down to expose the patellar tendon, patella and lower 5 inches of the rectus tendon. The patella is removed by any method desired. The repair is the important step in the operation. The rectus tendon is dissected 5 or 6 inches and raised as a flap. (Fig. 1.) The flap is raised by two longitudinal incisions on the side of the tendon from the site of the patella to the area of section. With a pair of scissors the flap can be dissected free of underlying structures. The proximal edge of the flap is cross cut as high as possible. The distal edge is left attached. This free end of the flap is to be used as a reinforcement in the patellar defect. An opening is made in the underlying structures just above the site of the patella. The flap is passed through this opening and carried down to the patellar tendon. An opening is now made in the patellar tendon, and the flap is passed through this opening and doubled back on itself for suture. This flap gives a double reinforcement over the gap made by excision of the patella. The flap is sutured in place. The skin is closed with sutures and a long-leg cast is applied. The plaster cast is left on for four to five weeks. Active quadriceps muscle exercises are done twenty times an hour for ten hours a day starting on the day of the operation.

FOLLOW-UP STUDY

A follow-up of the fifty-five patients who underwent patellectomy (fifty-eight procedures) was made in 1952 by one of the authors (A. E. DeN.).

The surgical procedures were performed in the years from 1946 to 1950. Eight operations were performed in 1946, fourteen in 1947, fourteen in 1948, ten in 1949 and twelve in 1950.

The preoperative diagnoses were as follows: comminuted fracture of patella, seven; transverse fracture of patella, four; osteochondral fracture of patella, two; refracture of patella, one; traumatic dislocation of patella, one; chondromalacia, thirty; old fracture of patella, two; osteoarthritis of knee, three; recurrent dislocation of patella, seven, chondroma of patella, one.

There were thirty-two females and twenty-three males. Bilateral patellectomy was performed in two females and one male. Eight patients were between the ages of 11–20 years, nine patients between 21–30 years, seven between 31–40 years, eleven between 41–50 years, and ten between 51–60 and 61–70 years, respectively.

The following questions were asked of each patient in the survey:

Is your knee improved? The acute fracture is not applicable and is excluded; there were fourteen cases in this group. *Answers:* forty-two, yes; one, no; one, unknown.

Does your knee ache? *Answers:* twenty-eight, no; seventeen, yes; twelve, yes with changes in the weather; one, unknown.

Does your knee get stiff? *Answers:* forty-four, no; fourteen, yes.

Does your knee give away? *Answers:* forty, no; eighteen, yes.

Do you use a walking aid? *Answers:* fifty-two, no; three, yes.

How far can you walk? *Answers:* fifty, unlimited; five, limited.

Have you changed your occupation? *Answers:* fifty-three, no; two, yes.

How long before the maximum result was obtained? *Answers:* one, 2 months; two, 4 months; two, 5 months; six, 6 months; two,

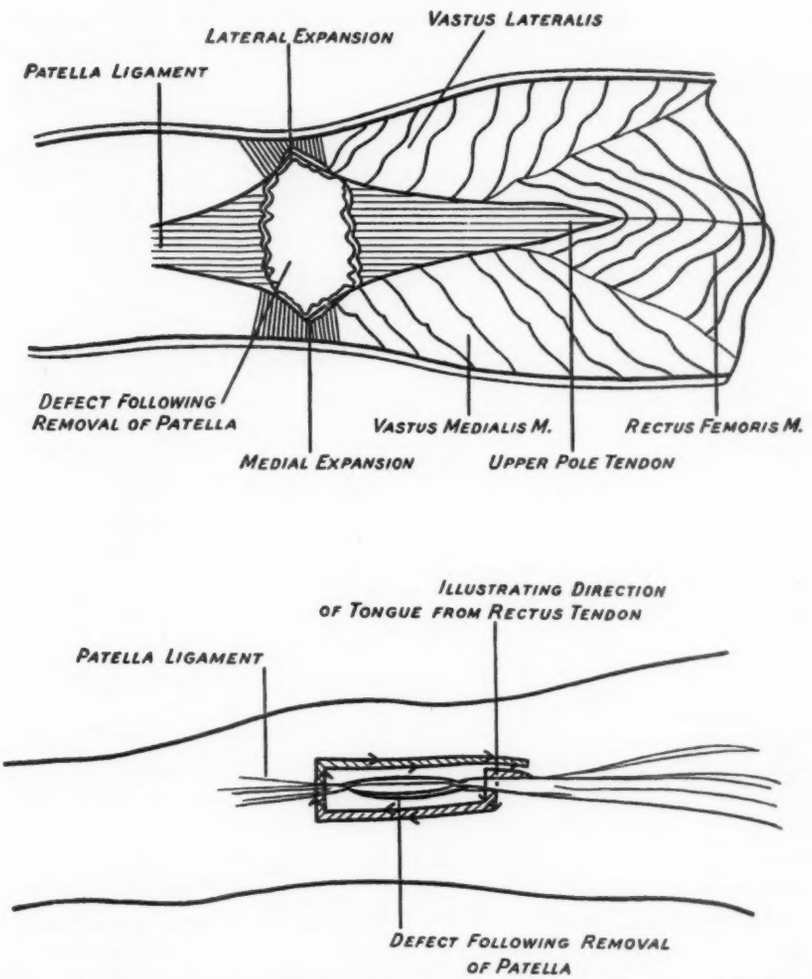

FIG. 1. Diagrammatic drawings of the flap of rectus tendon that is raised and used to repair the defect made by excision of the patella.

7 months; two, 9 months; one, 10 months; twelve, 12 months; six, 18 months; one, 24 months; thirty-five, unknown. The patients considered one year as the time of convalescence.

Is the limb straight at the knee on standing? *Answers:* fifty-seven, yes; one, no.

Can you walk up stairs? *Answers:* thirty-one, yes normally; eighteen, yes one step at a time; six, yes holding onto the rail.

Can you walk down stairs? *Answers:* thirty-one, yes normally; eighteen, yes one step at a time; six, yes holding onto the rail.

Can you stand on the leg alone? *Answers:* fifty-three, yes; five, no.

Can you kneel? *Answers:* thirty-nine, yes; nineteen, no.

What is your gait? *Answers:* forty-nine, normal; nine, locked knee on walking.

Can you run? *Answers:* thirty-four, yes; fifteen, no; five, afraid to try; two, have never tried; two, never could run.

Active motion of the knee is the most important factor in determining the end result. According to the number of procedures performed, the following results were tabulated:

Active extension to 180 degres.....	54 cases
Active extension to less than 180 degrees.....	4 cases
Active flexion to less than 90 degrees	10 cases
Active flexion to 90 degrees.....	5 cases
Active flexion to more than 90 degrees	9 cases
Active flexion complete.....	34 cases

The estimate of the clinical strength of the quadriceps muscle was done by testing the power of maintaining complete extension against resistance. In forty-four patients the

strength of the quadriceps muscle was good, and in fourteen it was considered poor. Atrophy of the quadriceps muscle was measured with a tape measure. No atrophy was measurable in thirty-two cases; however, there was atrophy of 1 cm. in five cases, 1½ cm. in two cases, 2 cm. in six cases, 3 cm. in four cases, and more than 3 cm. in nine cases.

TABLE 1
FUNCTIONAL END RESULTS OF PATELLECTOMY

Condition	No. of Cases	Good	Poor
Fracture of patella	14	10	4
Traumatic dislocation of patella	1	..	1
Chondromalacia of patella	30	25	5
Osteoarthritis and old fracture of patella with arthritis	5	4	1
Recurrent dislocation of patella	7	5	2
Chondroma of patella	1	..	1

Postoperative septic thrombophlebitis and pyarthrosis of the knee was a complication in one case. Infrapatellar hyperesthesia was a result in two cases, and regeneration of a small bony mass occurred in two other cases. Three patients complained of tender scar.

Typical patient comments were: (1) difficulty clearing toe when descending high steps; (2) cannot walk fast; (3) knee aches at times; (4) pain and swelling occur if quadriceps exercises are not done regularly. Surgery has been requested when the opposite knee has been painful. Two patients weighing 230 and 285 pounds, respectively, believed the corrected knees are good with their weight.

The condition of the opposite knee was evaluated. The knee was found to be normal in twenty-seven patients. Subpatellar crepitus, moderate to severe, was present in nineteen patients; one patient had a torn meniscus, three had arthritis of the knee and two had osteochondritis.

To consider the outcome of patellectomy "good," there must be complete extension to 180 degrees against gravity with a strong quadriceps muscle. Flexion must be to 90 degrees or more. The patient should have no complaints. The functional end result of the operation in this series was good in forty-four cases and poor in fourteen. (Table 1.)

The aftercare of patellectomy is the most important step in the therapy. The patient and physician must cooperate to obtain a good end result.

SUMMARY

Patellectomy is a good surgical procedure, required most frequently for the treatment of chondromalacia and traumatic injuries to the knee. A review has been presented of fifty-eight such operations in fifty-five patients, and the end results of the procedure have been given.

The defect made by excision of the patella must be repaired with rectus tendon.

Complete extension to 180 degrees must be preserved.

Recurrent dislocation of the patella is best treated by excision of the patella and repair of the quadriceps muscle mechanism.

Osteoid Osteoma of the Hand and Wrist

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SINCE the first description by Jaffe [2] in 1935 the lesion known as osteoid osteoma of the bone has been the subject of much writing and speculation. By 1945 Jaffe [3] was able to report on sixty-two proved cases. Lichtenstein [4] defined this lesion as a "small, oval or roundish tumorlike nidus which is composed of osteoid and trabeculae of newly formed bone deposited within a substratum of highly vascularized osteogenic connective tissue."

Several good reports and reviews of osteoid osteoma in general have been published, but it was not until 1953 that Carroll [1] offered a thorough review of such tumors found in a rather unusual location for them—the hand and wrist. He was able to find reports of only twenty-two cases of this type in the world literature, to which he added six cases of his own. His completed list of twenty-eight cases included tumors in the terminal and proximal phalanges, the metacarpals, and the navicular, capitate and hamate bones. He was unable to localize four tumors any more exactly than in the hand and wrist. Since then the finding of an osteoid osteoma in the terminal phalanx has been reported by Testa and Mazzoleni [7], and another similarly located tumor has been reported by Sevitt and Horn [5]. We wish to add to the list four more cases, in which the several tumors developed in a terminal phalanx, in a proximal phalanx, in the capitate and in the triquetrum. The last, we believe, is the first case of osteoid osteoma in that bone to appear in the literature.

The locations of the lesions in the hand and wrist can be seen in Figure 1. As yet, to our knowledge, there has not been any unmistakable report of an osteoid osteoma of the lunate, the pisiform or the greater or lesser multangular bones.

Osteoid osteoma appears to be essentially the same entity in its occurrences in the hand and wrist as it is elsewhere in the body, although modified by location. Although its etiology has been confused somewhat in the past with theories of embryonal arrest of cells and of low grade infective processes, most writers now agree that osteoid osteoma is a benign osteoblastic neoplasm as described by Jaffe [2].

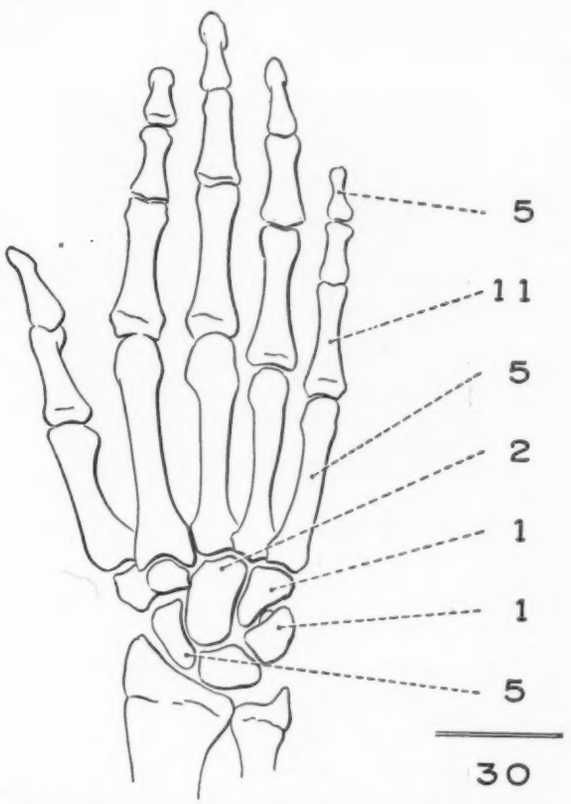

FIG. 1. Distribution of osteoid osteomas that have been accurately localized in bones of the hand and wrist.

Considered generally, the lesion is more

FIG. 2. Case I. (*a*) Osteoid osteoma of the capitate bone, before operation. (*b*) The same area after block excision of a portion of the bone. (*c*) Gross specimen of bone removed, including the nidus. (*d*) The patient's wrist one week after operation, with the plug of iliac bone in place.

FIG. 3. Case II. Sclerotic nidus of osteoid osteoma in the distal phalanx of the little finger.

common in men than in women by a ratio of approximately 2:1. Only one case has been reported in the Negro race. According to Sherman's [6] article of 1947, the ages of the patients ranged from three to fifty-one years, although the majority fell between the ages of eleven and thirty years and the incidence was especially high in patients in their late teens and early twenties. The lesions have been reported in every location except the skull. They seem to have some predilection for long bones, especially those of the lower extremity. The location within a bone may be entirely cancellous, cortical or subperiosteal.

Pain, the chief symptom, is characterized by a gradual onset over a period of two to twenty-four months. It reaches severe intensity and is worse at night. Aspirin relieves it almost in the manner of a specific agent. Other symptoms depend on the lesion's location, size and proximity to the surface or to the sensory component of nerves. On physical examination a swelling with an area of point tenderness sometimes can be noted. The patient's general health is not affected by the lesion.

Roentgenographic examination is valuable if one remembers the variety of pictures which osteoid osteomas can present, depending on their location. If the lesion is in cortical bone or abutting near the cortex, a great amount of sclerosis takes place; often this obliterates the lesion from the roentgenogram and necessitates planograms to locate the nidus. On the other hand, if the tumor is entirely in cancellous bone, it may have only a thin rim of sclerosis around it. The nidus is seen as a small round or oval area (usually less than 1 cm. in diameter) which may be either radiopaque or radiolucent. Jaffe [3] stated that early in the process the nidus was radiopaque with no surrounding sclerosis; but as it became more mature, resorption took place and the picture became that of a radiolucent area surrounded by a sclerotic area of varying size.

Treatment of the lesion is surgical; roentgenologic and antibiotic therapy have been to no avail. Simple excision is adequate if the nidus is completely removed; but if any remains, recurrences are almost certain to develop. Therefore we believe the ideal treatment for such a lesion in a bone of the hand or wrist is to remove a block of bone including the nidus; recurrences have not been reported

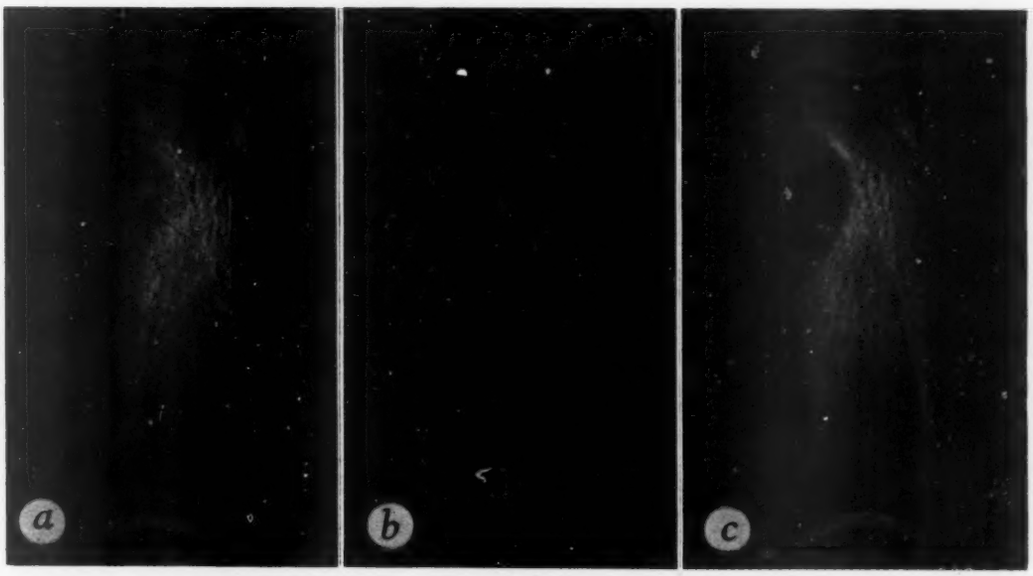

FIG. 4. Case III. The proximal phalanx of the index finger. (*a*) Showing a sclerotic nidus surrounded by an area of radiolucency. (*b*) After block excision of the involved portion of bone. (*c*) Two months later, with the edge of the cortical portion of the bone graft distinctly visible.

after complete removal. The relief of pain after complete removal is sudden. Microscopic examination of the excised specimen by a competent pathologist is required for absolute certainty of the diagnosis.

CASE REPORTS

CASE I. A twenty-one year old white man, an x-ray technician, came to the Mayo Clinic in October, 1955, because of pain of eighteen months' duration in the volar aspect of the right wrist. Inability to dorsiflex the wrist had developed gradually. Roentgenographic studies in several clinics had been reported negative until six months before admission. At that time a lesion in the capitate bone had been seen and diagnosed as a possible osteoid osteoma. Curettage of the capitate bone had been carried out, and the patient said that the lesion had been thought to be an eosinophilic granuloma. The limitation of motion continued but the pain was relieved for two months. Then, possibly in connection with a fall, the pain returned.

Physical examination disclosed right hypothenar atrophy. The patient could not fully extend the wrist and he lacked 1 inch of being able to flex the fingers into the palm. Tenderness was diffuse over the ulnar side of the wrist. Roentgenograms showed a radiopaque nidus in the capitate bone with surrounding osteoporosis, and around this was a ring of sclerosis. Surgical treatment consisted of block excision of the involved portion of bone, followed with fusion of the capitate to the hamate and the third and fourth metacarpal bones with a plug of iliac bone the exact size of the block removed. The pathologist reported an entire osteoid osteoma. (Fig. 2*a* to *d*.) The patient had immediate relief of pain, and three months afterward had acquired almost normal function of the wrist.

Comment. This is a good example of osteoid osteoma in a carpal bone. The method of treatment used offers, when applicable, the best chance for complete relief of all the symptoms.

CASE II. A seventeen year old white boy came to the clinic on March 28, 1955. Swelling and pain involving the distal phalanx of the right little finger had been present for two years. The pain was most pronounced at night and was relieved to a marked degree by aspirin. Physical examination revealed the dorsum of the finger to be slightly swollen and tender. Roentgenograms showed an oval area of increased density surrounded by a radiolucent area. (Fig. 3.) The diagnosis of osteomyelitis was considered. On March 29th a pea-sized nodule was removed and the pathologist reported "localized osteosclerosis." Six months later the patient's original symptoms had returned. Roentgenograms at this time showed mottled sclerosis with a central area of in-

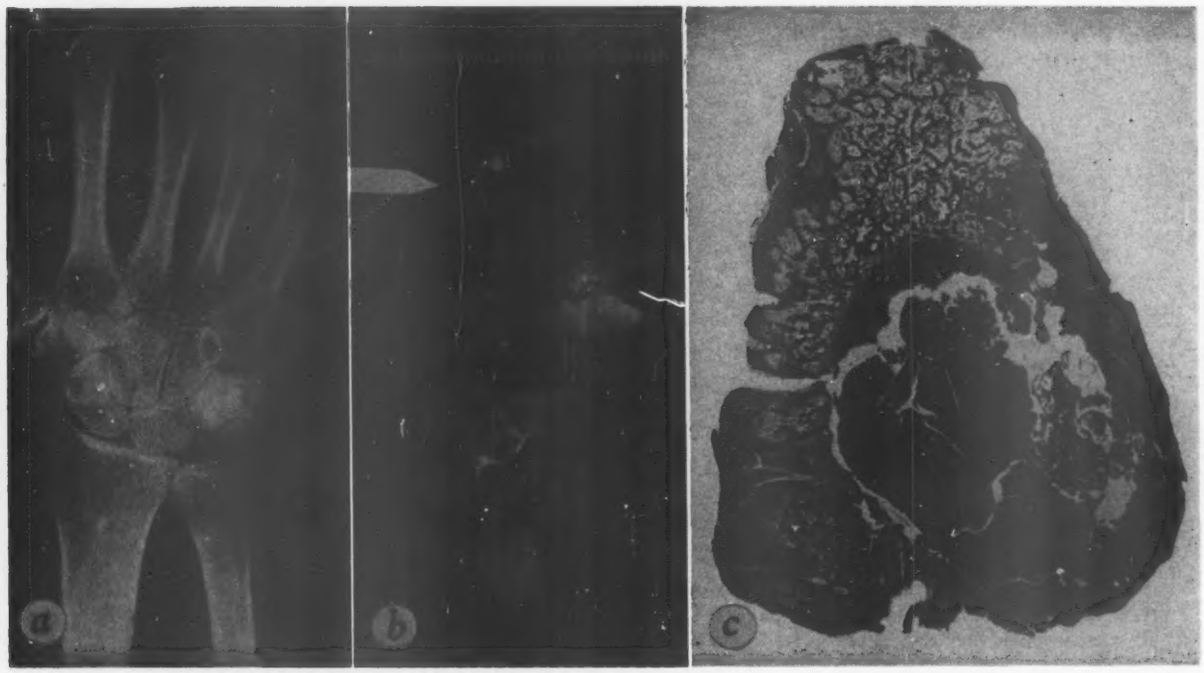

FIG. 5. Case IV. (*a*) Sclerotic nidus of the triquetral bone surrounded by an area of radiolucency. (*b*) The gross specimen that was removed; arrow pointing to the nidus itself. (*c*) The nidus and the surrounding bone. Hematoxylin and eosin, original magnification × 60.

creased density. The eventual treatment was amputation of the distal phalanx of the fifth finger; the final pathologic report was "osteoid osteoma, 5 mm. in diameter." The patient has been free of symptoms since.

CASE III. An eighteen year old white boy had noticed painless swelling of the proximal phalanx of the left index finger and gradual limitation of motion of the finger for one and a half years. Four months before he was seen at the clinic, a biopsy had been performed by the doctor in his home locality. The patient did not know the results. Roentgenograms taken on the patient's admission to the clinic in April, 1956, indicated rarefaction in part of the shaft of the proximal phalanx with proliferative changes surrounding this region. Treatment consisted primarily of removal of a roentgenologically localized block of bone measuring 4 by 8 mm. The resulting defect was filled with a plug of homogenous iliac bone. (Fig. 4*a* to *c*.) The patient's symptoms were completely relieved, the swelling having subsided and the motion having returned almost to normal when the patient was last seen four months later.

CASE IV. A nineteen year old white girl, a telephone operator, had injured her wrist by forced dorsiflexion two years before she was seen at the clinic. Continuing pain developed in the wrist. Without roentgenograms, according to the patient, a diagnosis of fracture had been made by the doctor in her home locality, but no treatment had been given at the time. However, as the pain continued and gradual swelling became evident on the ulnar side of the wrist, immobilization of the wrist by a short plaster of paris cast was tried repeatedly, but without relief. On admission to the clinic in March, 1956, the patient was suffering from swelling and tenderness just distal to the ulna on the right, and wrist motion was limited in all directions. Roentgenograms showed the triquetrum to be deteriorated, with a dense fragment in the center. Diagnoses considered were avascular necrosis and osteoid osteoma. Surgical treatment consisted of excising the distal 1 inch of the ulna along with the triquetral bone. An 0.8 mm. nidus of osteoid osteoma was found on pathologic examination. (Fig. 5*a* to *c*.) The pain disappeared almost immediately after operation and the patient has been free of symptoms since.

SUMMARY

The literature concerning osteoid osteoma has been reviewed briefly, with emphasis on

those instances in which the bones of the hand and wrist were affected. Added to previously published accounts of osteoid osteomas in this extremity are résumés of four personal cases, one of which was marked by localization in the triquetral bone, a site which had never before been reported.

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Henson and Rob in England studied follow-up results in 100 patients treated for duodenal ulcer by posterior gastroenterostomy and vagotomy (resection of at least 1 inch of each vagus nerve). The results were poor. The operative mortality rate was only 1 per cent but the rate of recurrence of the ulcer or of persistent preoperative ulcer symptoms, especially in a short time, was high. The authors justly conclude that these surgical procedures are not satisfactory surgical therapy for duodenal ulcers. (*Richard A. Leonardo, M.D.*)

Acute Postgastrectomy Pancreatitis

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ACUTE hemorrhagic or necrotizing pancreatitis arising as a complication of gastrectomy is fortunately rare. A recent review of the literature by Dunphy et al. [3] disclosed less than fifty cases of postoperative pancreatitis reported since 1940. In contrast, however, these authors reported eight cases of acute postoperative pancreatitis which occurred on their service in a two-year period. Surgeons are gradually becoming more aware of the menace arising from pancreatitis and that this complication occurs more frequently in the early postoperative period than present statistics indicate. The frequency with which this diagnosis is made reflects (1) the degree of suspicion of the surgeon, (2) the frequency of amylase determinations in suggestive cases, (3) the percentage of autopsies performed on this group, and (4) the heightened interest generally in acute pancreatitis.

Since there are no pathognomonic signs of acute pancreatitis its existence may be unrecognized. The one laboratory test upon which greatest diagnostic reliance is placed is the level of the serum amylase, yet the result of this test may be misleading. Normal levels do not rule out a diagnosis of pancreatitis. Some of the limiting factors which should be remembered in interpreting enzymatic levels are (1) the degree of obstruction of the large pancreatic duct, (2) the extent of destruction of acinar tissues, and (3) the stage of disease at the time the determinations are made.

There is no common etiologic denominator of acute pancreatitis. The solution to the problem of pancreatitis can be expected only as the summarization of causative factors from many reports contribute to our knowledge of this complicating surgical entity. The data for this paper were collected by analyzing and classifying statistical reports of 1,689 gastrectomies submitted by several V. A. Hospitals. (Tables I to III.)

We should like to enumerate the generally recognized factors in the pathogenesis of acute pancreatitis and to correlate the histopathologic features found in this series in relation to this etiologic classification.

Operative Trauma. Direct trauma to the pancreas from manipulation during the dissection of an adherent ulcer or from pulling on the duodenum in the process of its mobilization was the earliest etiologic factor to be recognized and ranks first in importance in the causation of acute postgastrectomy pancreatitis. Trauma, paradoxically as it may seem, does not consistently produce pancreatic disturbance. However, acute pancreatitis occurs four times more frequently when a duodenal ulcer is mobilized, as compared with the dissection of a gastric ulcer [10]. Usland [13] found a significant elevation of diastatic activity in the urine postoperatively in 13 per cent of gastric resections for duodenal ulcers. In a comparable preoperative series of ulcers penetrating the pancreas he found normal diastase values.

To minimize direct trauma to the pancreas during gastric operations, the resourceful surgeon has four alternative procedures: (1) Exclusion of the pylorus as proposed by Finsterer. This operative procedure carries a consistently higher incidence of marginal ulcer and is therefore not recommended. (2) Freeing the duodenum beyond the ulcer and buttonholing the wall at the site of the crater. The base of the ulcer is excluded but is not removed in this maneuver because of the proximity of the duct of Santorini and the frequency of its anatomic variations. However, this technic imposes a greater liability to pancreatic and biliary ductal injury. (3) Vagotomy with antral gastrojejunostomy which excludes the ulcer and eliminates the cephalic phase of secretion is the

TABLE I

CONCOMITANT COMPLICATIONS OF ACUTE PANCREATITIS

Case No.	Perforation of Duodenum or Stump	Lower Nephron Syndrome	General Peritonitis	Massive Terminal Hemorrhage	Etiology of Pancreatitis
I, died on 8th day.....	+	0	+ Bile	0	Perforation of common duct, operative trauma; serum amylase 1,338 units
II, died on 2nd day.....	0	Hemoglobinuric nephrosis	+	+	Anomaly of pancreatic ducts with transection of common duct and duct of Wirsung; serum amylase 200 units
III, hemorrhaged on 5th day	0	0	0	+	Operative trauma, cautery dissection; serum amylase 290 units
IV, died on 5th day.....	+	0	Left subphrenic abscess	0	Operative trauma, cautery dissection; serum amylase 97 units; peritonitis
V, died on 4th day.....	0	0	0	+	Operative trauma, cautery dissection; serum amylase 411 units; heart block

TABLE II

COMPOSITE STATISTICAL REPORT: TRENTON AREA

Data	No. of Cases
Gastric resections for duodenal and gastric ulcers	1,562
Gastric resections for carcinoma	127
Total resections, Trenton area, V. A. Hospitals	1,689
Surgical mortality	94 (5.5%)
Acute lethal pancreatitis	12 (0.7%)

TABLE III

STATISTICS FROM V. A. HOSPITAL, DAYTON, OHIO

Data	No. of Cases	No. of Deaths
Gastric resections for duodenal and gastric ulcers	348	18 (5.1%)
Gastric resections for carcinoma of stomach	34	9 (26%)
Acute lethal pancreatitis (25% of deaths)	...	5 (1.4%)

safest procedure and is gaining in general acceptance, but is contraindicated in an actively bleeding ulcer. (4) The two-stage gastric resection of McKittrick and associates [9]. The chief objection to the latter is that the patient is subjected to two major laparotomies which carry the risk, however small, of attendant complications and morbidity that may accompany any serious operation. Consequently, the staged operative procedure is seldom employed.

Injury to the Pancreatic Ducts. (Fig. 1.) We are indebted to Lahey [7], Marshall [8] Cattell [1] and Warren [14] for repeatedly calling attention to the possible complications which may ensue from injury to the biliary or pancreatic ducts. In the event any difficulty is encountered in identifying the common duct in relation to the ulcer, Cattell strongly advises cannulating it. In 1928 Schmieden and Sebening [12] reported that eleven of ninety-one cases of acute pancreatic affections following gastric operations were traceable to inadvertent ligation of the duct of Santorini. Vulnerability of this duct to injury has been previously emphasized by Clairmont [2] and Keyl [6] who have pointed out that a frequent site of injury is in the groove between the head of the pancreas and the duodenum. Incidentally, there is some evidence that such a complication occurred in our series.

Occasionally the greater and less often the minor papilla of Vater can be identified by palpation [10]. Since the papillae may vary in their anatomic relationship to the duodenum as well as to each other, their precise location

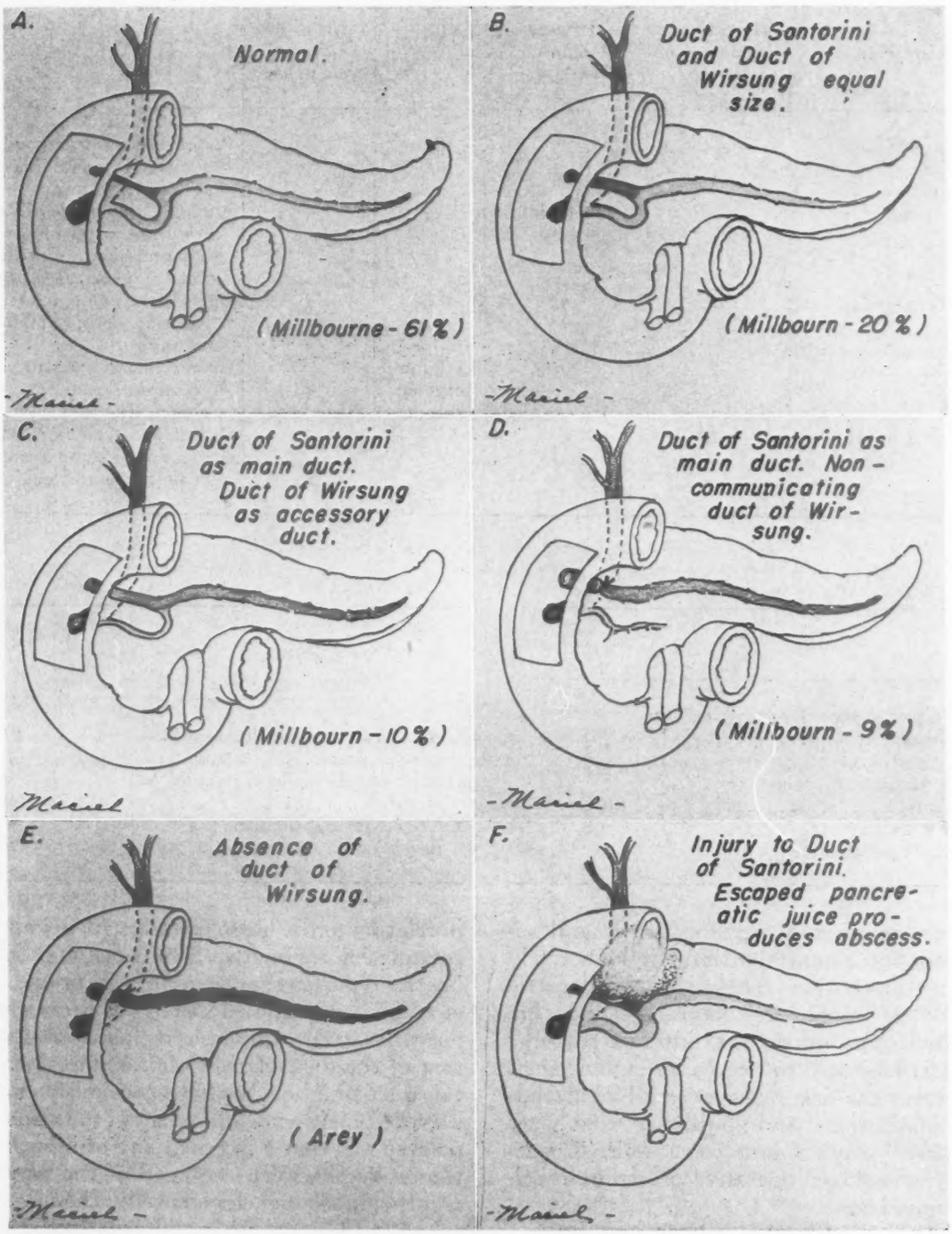

FIG. 1. A to C, shows normal and abnormal communicating variations of duct of Wirsung and duct of Santorini. Ligation of either duct may cause no serious complication. D, ligation of duct of Santorini, in this variant, the major duct, and non-communicating, causing almost complete obstruction of pancreatic outflow. E, ligation of duct of Santorini in absence of duct of Wirsung causing complete obstruction of pancreatic secretion. F, injury to duct of Santorini, as minor duct (normal relation) showing escape of pancreatic juice.

may be of value in preventing encroachment of the turned-in stump on the aperture of the duct. The closer the entry of the duct to the pylorus, the more susceptible it is to injury. According to the studies of Millbourn [*10*], the separation of the ulcerated duodenum from the head of the pancreas involves a 50 per cent risk of injury to the duct of Santorini. If the duct of Santorini communicates with the duct of Wirsung, untoward symptoms may not occur following its ligation (Nowak). Should the normal accessory duct be unknowingly divided or the ligature prematurely absorbed, leakage and subsequent formation of a peripancreatic abscess may result. Such an abscess may resolve spontaneously leaving no trace of its etiology except the duct of Santorini terminating blindly near the surface of the pancreas. However, to assume that the duct of Santorini can be ligated with impunity would be erroneous. Santorini's duct constitutes the main excretory duct in 10 per cent of patients. When this anomaly prevails, its occlusion is lethal. Theoretically it is advisable to identify the duct of Santorini and inject it with a contrast medium to determine whether it communicates with the duct of Wirsung or is the main excretory duct before it is ligated. However, this diagnostic maneuver is not practicable at this time.

Another source of injury to either pancreatic duct is in cauterizing the base of the ulcer when it invades the pancreas. A tissue slough from such a maneuver may expose a superficially placed duct, usually Santorini's if in the head or Wirsung's if in the body of the pancreas, with possible leakage. Any mechanical obstruction to the main duct increases the hydrostatic pressure in the ductal system which accelerates the passage of the enzymes into the interstitial spaces and subsequently into the peritoneal cavity. It has also been postulated that the rise of intraductal pressure produces injury to the acinar cells and perhaps alters the trigger mechanism for the escape of enzymes. However, it has been shown that elevation of intraductal pressure too low to cause any histologic alteration in the acinar cells can produce marked rise in serum enzyme levels [*13*]. Therefore, the intraductal pressure, like trauma, in itself is not the sole determinant factor in enzymatic escape into the peritoneal cavity.

Vascular Anomalies. (Fig. 2.) The normal blood supply to the pancreas is fully adequate to meet the usual demands made upon it. Ordinarily, sufficient collateral vessels are present to compensate for damage to either the gastroduodenal or inferior pancreaticoduodenal arteries, provided they are of normal caliber. If there is an anomalous origin of either principle vessel with concomitantly reduced arborization, the potential possibility of impairment of the circulation to the pancreas arises. Such anomalies have been described by Ziegler [*15*] and Pierson [*11*] who have made important contributions to a better understanding of these variations in the vascular supply to the duodenum or pancreas.

Normally the pancreas is supplied by two arteries from the gastroduodenal, one from the superior mesenteric and one which arises from either the splenic, hepatic or celiac arteries. Some of the anomalies of the anterosuperior pancreaticoduodenal and of the inferior pancreaticoduodenal arteries, which have been demonstrated by the anatomic dissections of Pierson [*11*] and Ziegler [*15*], are illustrated. Ziegler, in his series comprising twenty-four vascular dissections, found the normal textbook arrangement in only one-third of the specimens. It is therefore conceivable that circulatory impairment of the pancreas might ensue if the gastroduodenal artery were ligated in the absence of the inferior pancreaticoduodenal artery. Similarly, in those cases in which the middle colic artery is a continuation of the gastroduodenal, ligation of the latter might jeopardize the circulation of the bowel supplied by it.

The important factor to remember is that these vascular variations occur with sufficient frequency to emphasize the need for the surgeon to be familiar with them. Such knowledge may preclude the possibility of producing ischemia of the pancreas or duodenum by the injudicious ligation of an anomalous vessel.

Stagnation of the Duodenal Contents. The mode of entry of pancreatic enzymes into tissue spaces is incompletely understood. Duodenal stagnation, if accompanied by increased intraluminal pressure, may conceivably cause retrojection into the major pancreatic duct in the presence of an incompetent sphincter of Oddi. In the presence of spasm of the sphincter of Oddi, the duodenal content has another possible avenue of escape through the accessory papilla (Santorini) which has no sphincter mechanism. Should the accessory duct be of a

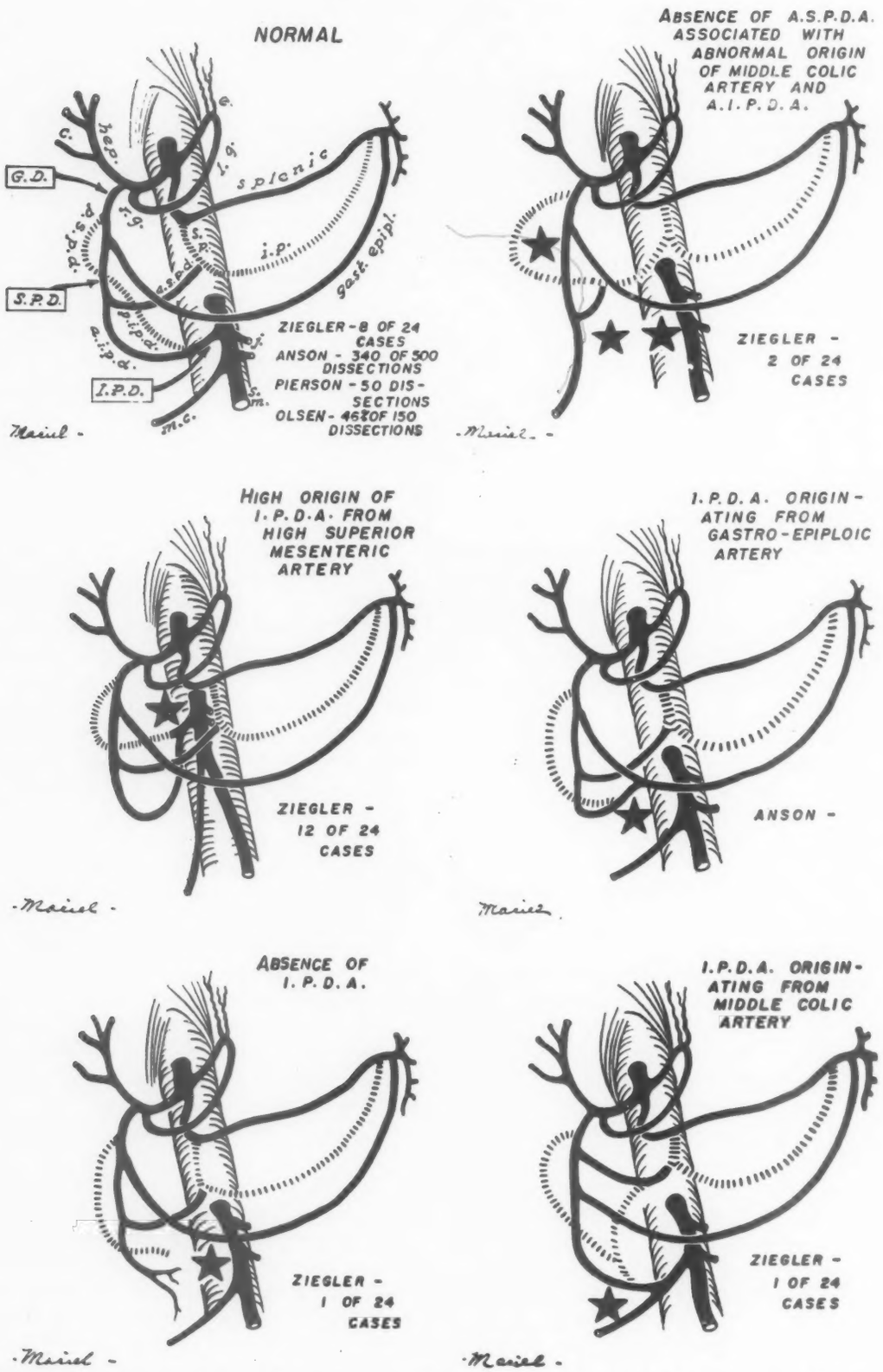
NORMAL
G.D.
S.P.D.
I.P.D.
splenic
ZIEGLER - 8 OF 24 CASES
ANSON - 340 OF 500 DISSECTIONS
PIERSON - 50 DISSECTIONS
OLSEN - 46% OF 150 DISSECTIONS
ABSENCE OF A.S.P.D.A. ASSOCIATED WITH ABNORMAL ORIGIN OF MIDDLE COLIC ARTERY AND A.I.P.D.A.
ZIEGLER - 2 OF 24 CASES
HIGH ORIGIN OF I.P.D.A. FROM HIGH SUPERIOR MESENTERIC ARTERY
ZIEGLER - 12 OF 24 CASES
I.P.D.A. ORIGINATING FROM GASTRO-EPIPLOIC ARTERY
ANSON -
ABSENCE OF I.P.D.A.
ZIEGLER - 1 OF 24 CASES
I.P.D.A. ORIGINATING FROM MIDDLE COLIC ARTERY
ZIEGLER - 1 OF 24 CASES

FIG. 2. Anatomic vascular variations of the pancreas. The star indicates the site of the anomaly. I.P.D.A.: inferior pancreaticoduodenal artery. A.S.P.D.A.: anterior superior pancreaticoduodenal artery. A.I.P.D.A.: anterior inferior pancreaticoduodenal artery.

larger size so that it could function as a substitute for the duct of Wirsung, the reflux theory under such circumstances would seem tenable. In those instances in which no ductal or vascular injury can be demonstrated and there is no evidence of stasis, one must consider the possibility of infection invading the pancreas and activating the pancreatic enzymes, as postulated by Warren [*14*].

CASE REPORTS

The following five cases of acute postoperative pancreatitis were taken from records of 348 gastrectomies performed at the V. A. Hospital, Dayton, Ohio.

CASE I. K. C. B. (No. R-125,069), a forty year old white man, was admitted with the chief complaint of pain in the epigastrium and nausea and vomiting occurring intermittently for six years. A perforated ulcer had been closed two years previously. Under an ulcer regimen he had remained fairly comfortable until a few months prior to admission. For the past two weeks his stools had been tarry, associated with a weight loss of 15 pounds in two months. Examination disclosed deep tenderness in the mid-epigastrium and to the right of the midline. X-rays revealed a dilated stomach with 90 per cent retention on the six-hour film. The blood picture was normal.

Subtotal gastric resection, Billroth I-Hoffmeister, was performed on October 13, 1949. The duodenum was inadvertently perforated while being freed from the head of the pancreas. The patient's postoperative course was smooth for five days; then severe upper abdominal pain suddenly developed, followed by distention. The serum amylase was 1,338 units. The next day the serum amylase was 648 units. The diaphragm on the right was high. Despite administration of adequate blood and plasma, the patient rapidly deteriorated and died on the eighth postoperative day.

Postmortem examination showed a gangrenous focal pancreatitis of the head with perforation of the common duct. Bile was observed to escape from the perforated duct which was in the transpancreatic portion and the site where the pancreas had been sutured in the base of the ulcer. A probe introduced into the papilla of Vater ended blindly. Further search for the duct of Wirsung or the duct of Santorini was not made.

Comment: It was shown that the common duct had been inadvertently perforated in freeing the crater of the duodenal ulcer and was responsible for the necrotizing pancreatitis. From available autopsy findings it is not known if there were coincidental injury or obstruction to either of the pancreatic ducts. The latter is implied by the fact that the probe ended blindly in the papilla of Vater. Since pancreatic juice is clear, as contrasted to the yellowish color of bile, transection of the pancreatic duct may be overlooked.

CASE II. S. W. (No. R-135,538), a fifty-nine year old white man, was admitted to the hospital on July 9, 1951, after having passed many tarry stools during the last twenty-four hours. Gastroenterostomy had been performed in 1934 for pyloric obstruction. He was relieved for three years, after which hematemesis and melena developed. These episodes of hemorrhage were repeated in 1940, 1942, 1944 and 1950. Gastric resection was recommended but refused in 1950. Examination showed a pale, apprehensive man complaining of moderate epigastric tenderness. Blood pressure was 88/58, hemoglobin 8.5 gm. per cent, and blood urea nitrogen 29 mg. per cent. He was given two units of blood immediately. Following this the bleeding stopped.

At operation, the gastrojejunostomy was uncoupled but no marginal ulcer was demonstrable. During the process of freeing the duodenum from the pancreas, much dense scar tissue was encountered which surrounded a crater, making it difficult to identify the structures. The common duct and the main pancreatic duct were divided during the dissection but were reimplanted in the duodenum. A T-tube was placed in the common duct. The patient was in shock at the end of the operation. The systolic pressure ranged from 70 to 90 for thirty-six hours. Meanwhile he received blood transfusions, fluid and oxygen. At the end of the first postoperative day jaundice was present; serum bilirubin was 5.4 mg. per cent, serum amylase was 200 units and the urinary output was 230 ml. The second postoperative day the urinary output was 50 ml. and blood urea nitrogen was 90 mg. per cent. On the evening of the second postoperative day the

patient coughed up some bright red blood, and apparently died suddenly of aspiration.

Postmortem examination revealed hemoglobinuric nephrosis and massive hemorrhage from an unknown source in the gastroduodenal area. The anastomotic stoma, choledochoduodenostomy and pancreaticoduodenostomy revealed no leakage. The pancreas was pinkish yellow with necrosis and softening of the head; there was extensive retroperitoneal fat necrosis and aspiration of blood into the tracheobronchial tree with partial atelectasis of both lungs.

Comment: The source of the terminal massive hemorrhage was not determined but is known to occur in pancreatic affections. The hemoglobinuric nephrosis was traceable to an unrecognized transfusion reaction. The peripancreatic fat necrosis augmented by intrinsic changes in the head of the pancreas probably arose from direct trauma due to extensive surgery since no leakage from the anastomoses was demonstrable. In the etiologic classification, the pancreatitis was attributed to trauma arising incident to the mobilization and suture of the transected common duct and main pancreatic duct. Whether or not the patient would have survived the incompatible blood transfusion without the menace of a complicating pancreatitis is debatable.

Case III. V. Z. (No. R-162,381), a sixty-four year old white man, was admitted to the hospital for the third time for treatment of a duodenal ulcer. The present exacerbation of pain had started two weeks before, but he had had no hematemesis or melena. There was moderate epigastric tenderness. Gastrointestinal series showed deformity of the duodenal bulb with pseudodiverticulum and a true diverticulum of the second portion.

The patient failed to improve on intensive medical treatment and on March 28, 1955, subtotal gastric resection, Billroth II anastomosis, with vagotomy was performed. He ran a stormy course from the beginning; his temperature was 102 to 104°F. Several bronchoscopies and finally tracheotomy were performed. A film of the chest revealed infiltration at the right base. Serum amylase was normal until the fourth day when it rose to 290 units. Immediately, routine therapy for acute pancreatitis was started consisting of pro-banthine,® serum albumin, blood transfusions and gastric suction. On the fifth postoperative day the patient had a massive hemorrhage from the nose, mouth and tracheotomy tube. He died a few minutes later.

Postmortem examination revealed acute necrotizing pancreatitis with abscess and fat necrosis, and pulmonary edema and congestion. The source of hemorrhage was not determined. The anastomosis was intact.

Comment: At operation an adherent duodenal ulcer was dissected from the pancreas with the cautery exposing a large raw area. The serum amylase was slow in rising and was only slightly elevated despite a fulminating pancreatitis. We are at a loss to explain the exsanguinating hemorrhage on the fifth postoperative day, and the pathologist failed to throw any light on this point. However, the possibility of an anticoagulating action of trypsin is postulated as the causative factor for the hemorrhage.

Case IV. T. N., a sixty year old man, was admitted with a twenty-five to thirty–year history of periodic ulcer pain relieved by taking soda and milk. The past three years the pain had been more or less constant despite various antacids and a dietetic regimen. During the past year he had worked about half the time. He denied hematemesis or melena. There was moderate tenderness to the right of the midline and in the epigastrium. Twelve-hour night secretion was 800 ml. with 85 degrees free acid. Chest x-ray and gallbladder series revealed no abnormalities. Gastrointestinal series revealed a large active ulcer in the lower recess of the bulb.

On June 9, 1955, vagotomy and subtotal gastrectomy (Hoffmeister-Billroth I type) were performed. There was scarring of the bulb with inflammatory changes involving the posterior wall with penetration into the head of the pancreas. Electric cautery was used to control bleeding from the head of the pancreas. The duodenum was entered on the pancreatic side. The patient did well until the third postoperative day when he became dyspneic, apprehensive, and complained of dull pain in the lower abdomen. His temperature was 102°F.; coarse rales were heard at the lung bases and there was hypoactive peristalsis. The pain migrated to the upper abdomen the next day. Acute peritonitis or pancreatitis was suspected. Serum amylase was 97 units. The patient died on the fifth postoperative day.

Postmortem findings were acute fulminating pancreatitis with focal necrosis of the head; fat necrosis, retroperitoneal, omentum and mesentery; and left subphrenic abscess and acute peritonitis.

Comment: Again, in freeing the penetrating ulcer associated with inflammatory changes of recent origin, there was considerable trauma which was unavoidable. The duodenum was buttonholed at the base of the ulcer to reduce trauma and to lessen the chance of ductal injury. The left subphrenic abscess and general peritonitis played causative roles. The duodenal stump was intact. The normal amylase level is explained on the basis of extensive parenchymal destruction. There was an extensive retroperitoneal phlegmon, incriminating a wide enzymatic spread possibly from cauterization of the ulcer bed.

CASE V. M. F. B. (No. R-145,502), a seventy-six year old white man, was admitted on January 20, 1955, complaining of burning epigastric pain of two months' duration. This distress was not related to meals but was relieved by milk and antacids. The patient had many previous admissions to the hospital for chronic glomerulonephritis and severe hypertensive cardiovascular disease with myocardial damage. On a hospital admission in 1950 he had complained of tarry stools; his hemoglobin was 3.5 gm. per cent. X-rays at that time revealed a hiatus hernia. On the present admission it was learned that the patient had passed tarry stools a few hours before. Hemoglobin was 7 gm. per cent and hematocrit was 24 volumes per cent. After multiple transfusions hemoglobin rose to 10.3 gm. per cent and hematocrit to 38 volumes per cent: On January 23rd gastrointestinal series showed a constant fleck in the duodenal cap. With these findings and the history of previous hemorrhages, gastrectomy was advised and performed on January 29th.

A large duodenal ulcer had eroded into the pancreas. The ulcer was freed and gastrectomy, Hoffmeister-Billroth II, was performed. The patient's postoperative course was uneventful for twenty-four hours; then cyanosis and severe precordial pain developed. An electrocardiogram revealed a bundle branch block with definite evidence of myocardial infarction. After tracheotomy the patient's cyanosis improved markedly. X-ray of the chest was negative. Blood pressure was 120 to 150 systolic. On the second postoperative day he became cold and clammy with recurrence of cyanosis of the nailbeds. Serum amylase was 411 units; thus, a diagnosis of acute pancreatitis was made in addition to the myocardial infarction. He was given 150 ml. of serum albumin and one unit of blood. His temperature rose to 105°F. and he lapsed into a coma. On the third postoperative day peritoneal tap revealed grossly bloody fluid. His condition rapidly deteriorated, and he died at 8:55 A.M. on February 1st.

Postmortem examination showed acute hemorrhagic pancreatitis with focal parenchymal necrosis; myocardial infarction, left ventricular wall; competent gastrojejunal anastomosis; fat necrosis, omentum and retroperitoneal tissues. There was 800 ml. of serohemorrhagic fluid in the peritoneal cavity.

Comment: Trauma most likely was the exciting factor in the development of pancreatitis. Equally important in causing the patient's death was the myocardial infarction with bundle branch block. It would be very difficult to assess proportionally these two lethal complications which occurred almost simultaneously. However, acute hemorrhagic pancreatitis was given as the immediate cause of death. If the ulcer had been excluded there would have been less likelihood of pancreatitis developing, but the potentiality of subsequent exsanguination from the bleeding ulcer is greater than the incidence of pancreatitis.

COMMENTS

An analysis of this combined series of 1,689 gastric resections revealed that 1,562 were performed for benign ulcers, 127 for adenocarcinoma of the stomach, and one for sarcoma of the stomach. The over-all mortality rate was 5.5 per cent. Twelve of the ninety-four deaths (12.7 per cent) were due to acute pancreatitis. Consequently, the mortality due to acute pancreatitis was responsible for 0.7 per cent of the total number of cases.

A further breakdown of the deaths from pancreatitis reveals that five of the twelve occurred at Dayton Veterans Administration Hospital where approximately one-fourth of the total gastric resections were performed. It can be noted in Table I that in two cases the serum amylase values were increased, in two they were equivocal, and in one the value was

normal. The equivocal or normal amylase findings are explained on the basis of an overwhelming phlegmonous infection resulting in extensive acinar destruction. Technical errors occurred in two patients, both with bleeding ulcers but who merited resection. These complications might have been prevented by cannulation of the common duct and the intraduodenal insertion of the finger as a guide during the dissection of the ulcer. The one probable lethal blood transfusion reaction is not chargeable to the surgeon. Coincidentally, three terminal massive hemorrhages remain unsolved. Similarly, Case v presented a combination of factors to assess.

We believe that the presently accepted criteria for resectional surgery, particularly for difficult duodenal ulcers, have been followed too rigidly. There is need for greater flexibility in the choice of operation with due consideration being given to the surgical complications which may ensue. The ideal operation for a duodenal ulcer does not lend itself to standardization. Its selection must, of necessity, depend upon the interpretation of the pathologic findings, the patient's general condition, and the skill and judgment of the surgeon. In general, the operation selected should be the one that is least traumatizing, offers the greatest protection from injury to important anatomic structures, is most physiologic, and at the same time maintains effective control of the ulcer symptoms. If the ulcer crater is surrounded by pancreas, it is preferable to leave the base by buttonholing the wall of the duodenum. As a further precaution we would warn against excision, curettement, or cauterization of the base of the ulcer. In those patients in whom the ulcer penetrates the pancreas, vagotomy with antral gastrojejunostomy should be given priority. Had this dictum been followed the mortality rate in the Dayton series would have been reduced from 1.4 to 0.8 per cent. When hemorrhage is the predominant symptom, resection of the involved duodenum should be performed. In the very poor risk patient it may be advisable to limit the operative procedure to simple ligation of the bleeding vessel with closure.

Anomalies of the biliary and pancreatic ductal system and of the blood supply to the duodenum and pancreas, while rare, occur with sufficient frequency to alert the gastric surgeon to be cognizant of these variations.

The various factors contributing to pancreatic necrosis can be best understood by placing them in three categories: (1) Those due to ductal obstruction: the increased intraductal pressure influences the escape of the enzymes into the interstitial spaces. The intraglandular tissue or regional reaction may be augmented by toxic products from disintegration of the acinar cells. (2) Those attributable to variations in the pancreatic secretion such as the amount, concentration and state of the proteases. (3) The resistance of the pancreas to the liberated enzymes. The susceptibility of the pancreas may be altered by trauma, impairment of the blood supply and chemical and metabolic disturbances in the pancreas. We believe this simple outline proposed by Grossman [5] has been useful and helpful in gaining a better understanding of a retinue of clinical and experimental observations on the causation of acute pancreatitis.

CONCLUSIONS

1. Pancreatitis may be a lethal but infrequent postoperative complication of gastric surgery. In one series of 348 gastric resections there were five (1.4 per cent) deaths from acute pancreatitis. In another larger series comprising 1,689 gastric resections there were twelve (0.7 per cent) deaths from pancreatitis.

2. Trauma to the head of the pancreas and injury to the biliary or pancreatic ducts are the most frequent and important causative factors of pancreatitis.

3. Difficult duodenal dissections for penetrating or cicatrizing ulcers should be performed very cautiously. Gastrojejunostomy with vagotomy may be preferable to gastric resection in these cases.

4. Actively bleeding duodenal ulcers must still be treated either by resection or by ligation of the bleeding point in the very poor risk patient.

5. Postgastrectomy pancreatitis must be treated vigorously. If the etiology is intrinsic and not perpetuated by damage to the biliary or ductal system, the prognosis is greatly enhanced.

6. Anomalies of the pancreatic ducts and the blood supply of the pancreas are deserving of greater emphasis.

7. Many diagnostic, clinical and therapeutic features of acute pancreatitis remain unsolved.

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Annular Pancreas

ERRORS IN DIAGNOSIS AND TREATMENT OF EIGHT CASES

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THE term "annular pancreas" is applied to a developmental anomaly in which a ring of pancreatic tissue encircles the descending portion of the duodenum. This anomaly was first described by Tiedemann [*24*] in 1818, and nearly all of the early cases were found at autopsy. More recently this anomaly has been diagnosed with greater frequency in living patients. The variety of surgical technics employed in the treatment of this condition and the complications reported indicate the need for more standardized diagnostic and surgical procedures. The purpose of this paper is to present the important clinical, laboratory and operative findings in eight patients with annular pancreas together with a discussion of the common diagnostic and surgical errors. Three characteristic roentgenographic findings are presented as an aid in the diagnosis of this anomaly.

Payne [*15*], in 1951, reviewed the medical literature and briefly reported the case histories of fifty-five patients in whom a diagnosis of annular pancreas had been confirmed. He added a case of his own, which represented the eighteenth case surgically treated. In 1953, Kiesewetter and Koop [*10*] reviewed the histories of eighty cases, including seven pediatric cases of their own. Six of their seven patients underwent operation and two survived the surgical procedure. A year later, Skapinker [*21*] found seven additional reports of cases of annular pancreas treated surgically and added one of his own. These and subsequent case reports, including eight in this report, makes a total of eighty-eight cases of annular pancreas that have been treated surgically. However, the exact preoperative diagnosis was made relatively infrequently.

EMBRYOLOGY

Developmental defects producing annular pancreas have been well described by Arey [*1*] and Shapiro *et al.* [*20*]. These authors show that the pancreas arises by a dorsal and ventral outgrowth from the portion of the primitive intestine which later develops into the second part of the duodenum. The dorsal anlage grows across the human body until it reaches the spleen. It forms the tail, body and a portion of the head of the pancreas. The duct opens into the duodenum above the orifice of the common bile duct and is called the duct of Santorini. The ventral anlage consists of two buds, a right and left, arising on each side of the common bile duct. As the intestine elongates and rotates clockwise, the left bud atrophies and the right ventral anlage, together with the common bile duct, rotates dorsally around the right side of the bowel and fuses with the dorsal bud, forming the remainder of the head and uncinate process of the pancreas. The right ventral bud contains a duct that unites with the duct of the dorsal anlage at its proximal end. The distal portion of this duct ends in the duodenum close to or in common with the termination of the common bile duct. This duct is known as the duct of Wirsung.

Three theories are postulated regarding the formation of annular pancreas. Lecco [*11*] believes that the right ventral anlage becomes adherent to the duodenum during rotation and the resulting stretching of the pancreas produces the characteristic defect. Baldwin [*2*] proposes that, in addition, the annulus is caused by the growth instead of normal atrophy of the left ventral anlage. Tieken [*25*], however, believes that annular pancreas is the result of simple hypertrophy of the ventral and dorsal

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anlages. In the majority of patients with annular pancreas who were subjected to careful dissection at autopsy, the annulus had a main duct that originated in the pancreatic ring on the left anterior surface of the duodenum. This duct passed dorsally around the right side of the duodenum, then opened posteriorly into the duct of Wirsung near the ampulla. These findings tend to refute Tieken's theory of pancreatic hypertrophy.

PATHOLOGY

The pathologic picture is that of partial or complete encirclement of the second portion of the duodenum by a ring of pancreatic tissue which is continuous with the pancreas. This defect produces varying degrees of obstruction of the underlying duodenum. Microscopically the annular pancreas usually consists of normal-appearing pancreatic tissue, but occasionally pancreatitis is present. The annulus may produce obstruction of the common bile and pancreatic ducts, and the underlying duodenum may exhibit thinning with loss of normal mucosal structure.

Other congenital defects are commonly associated with this anomaly and must be recognized. Mongolism has been noted frequently as well as malrotation of the intestine and atresia of the esophagus, duodenum and anus. Tracheoesophageal fistulas, deformities of the urinary tract and clubfoot have been reported in a few cases.

DIAGNOSIS

Seventy-five per cent of the reported cases of annular pancreas occurred in males. The presence and the severity of symptoms depend upon the degree of duodenal obstruction. In the newborn, persistent jaundice may be caused by compression of the common bile duct by the annulus or the distended duodenum, thus simulating atresia or malformation of the bile ducts. Duodenal obstruction may be complete, attended by profound electrolyte disturbance and dehydration. Death may occur suddenly unless the condition is recognized and treated promptly.

In older patients the onset of symptoms may be sudden and simulate acute cholecystitis or perforated peptic ulcer. Such cases are usually precipitated by the onset of acute pancreatitis in the annulus due most likely to obstruction of the annular duct. Chronic gastritis and peptic ulcer accompany many cases of annular pancreas. Sanford [*19*] noted a high incidence of peptic ulcer formation (34 per cent) at the time of or subsequent to surgical treatment. Retention of food in a dilated pouch proximal to the annulus interferes with normal function of the pyloric sphincter and may be a stimulus for antrum hyperfunction. This produces excessive liberation of the hormone gastrin with resultant gastric hypersecretion and hypermotility [*14*].

More often, the complaints are vague—poorly defined epigastric distress, relieved or aggravated by food and associated with upper abdominal fulness or periodic vomiting after meals. Peptic ulceration associated with annular pancreas adds to the bizarre symptoms, especially when hematemesis or occult blood in the stools, or both, also are present. Jaundice in the adult further complicates the diagnosis. Laboratory studies are not comfirmatory. Gastric analysis may reveal increased or diminished secretion of acid-pepsin. In patients with acute duodenal obstruction, lowered serum proteins, elevated serum bilirubin and macrocytic anemia as well as elevation of serum lipase and amylase may be noted.

Careful roentgenographic studies are the *sine qua non* in the diagnosis of annular pancreas. Infants frequently exhibit signs of high intestinal obstruction during the first week of life. Survey films of the abdomen with the patient in supine and erect positions are necessary. Dilatation of the stomach and duodenum is present, with little or no gas demonstrable in the intestinal tract distal to the obstruction. Kiesewetter and Koop [*10*] speak of the "double-bubble" sign, characterized by dilatation above and below the annulus with the stenotic portion clearly outlined. If the diagnosis is doubtful, a plastic tube may be passed into the stomach and a radiopaque aqueous solution instilled. The use of this solution obviates the danger of barium or oil aspiration and the development of pneumonia, a frequent cause of death in infants [*10,29*].

Three roentgenographic findings were present in five of our eight cases, which enabled one of us (R. O. T.) to make a diagnosis of annular pancreas prior to surgery. Review of the roentgenographic and fluoroscopic findings in the remaining three cases confirms the value of these signs. The first sign is the smooth annular filling defect of the second and occasionally the third portion of the duodenum. The second is the varying degree of symmetric dilation of the

duodenum proximal to the constriction. The third diagnostic sign is the fluoroscopic evidence of reversed peristalsis present in the duodenum proximal to the obstruction. The latter finding is present in cases of more advanced degrees of obstruction.

Differential diagnosis should include duodenal diverticula, aberrant pancreas, tumors of the duodenum, inflammatory changes and compression of the duodenum by the superior mesenteric vessels. Confusion between duodenal dilatation and a large diverticulum has occurred in several reported cases [*17*]. Differentiation should not be difficult since the dilatation caused by annular compression involves the entire duodenum and the characteristic narrowing is absent at the point of origin of the diverticulum. The stalk of the diverticulum usually can be demonstrated by barium studies. Aberrant pancreatic tissue in the duodenal wall produces a more circumscribed and irregular filling defect arising along one of the walls of the duodenum. Duodenal polyps are uncommon. The roentgenographic appearance of a "vacuole" type of filling defect has been described by Golden [*7*]. The duodenal mucosa surrounding the polyp appears normal.

Lipomas, malignant lymphomas and carcinoma of the duodenum are rare and present irregular filling defects and distortion of the duodenal mucosa [*9*]. Inflammatory changes associated with chronic duodenal ulcer may simulate annular pancreas and produce similar roentgenographic findings. Primary chronic cicatrizing duodenitis or tuberculosis of the duodenum are extremely rare. Both conditions produce extensive and irregular involvement of the duodenum.

TREATMENT

Surgical intervention for annular pancreas should be undertaken only when there are definite symptoms resulting from obstruction of the duodenum and/or the common bile and pancreatic ducts. A review of the reported cases shows a complete lack of uniformity in surgical technic. In general, some type of a bypassing operation has been performed or an attempt has been made to resect the annulus. The types of treatment include simple drainage of the abdominal cavity, division or resection of the annulus occasionally supplemented by a Heineke-Mikulicz procedure, duodenojejunostomy, gastroenterestomy and gastric resection.

Some authors, such as Cattell [*4*], Warren [*28*] and Payne [*15*], have reported serious complications as well as failure to relieve the patient's symptoms following resection of the annulus. Pancreatic fistula has occurred frequently and duodenal obstruction has persisted. Transection of the pancreatic duct frequently present in the annulus would tend to encourage formation of fistulas even though the duct is well ligated. The scarring and narrowing of the duodenum at the site of obstruction are usually pronounced, and resection of the ring of pancreas cannot be expected to relieve the obstruction. This observation is confirmed in the majority of cases in which the ring has been divided or resected.

Gastroenterostomy has been performed a number of times since the first successful case was reported by Vidal [*27*] in 1905. Although this technic is acceptable in an older patient, the danger of subsequent marginal ulcer formation would suggest the advisability of simultaneous transabdominal vagotomy. Several patients have been treated by partial gastrectomy. This procedure should be performed only when the generally accepted indications for gastrectomy are present. When jaundice results from compression of the common bile duct, gastric resection is interdicted unless the biliary obstruction is relieved simultaneously. If duodenal obstruction is precipitated by acute pancreatitis in the annulus, gastric resection would appear to be a hazardous procedure.

Duodenojejunostomy is usually recommended as the procedure of choice in infants and has been employed in adults with equal success. Careful review of the reported cases shows that after this procedure the dilated stomach of an infant may fail to regain normal tone with persistence of gastric dilatation and malfunction of the stoma (Case VIII). The proximal duodenum may not be sufficiently dilated for the performance of a quick anastomosis, and mobilization of the duodenum may precipitate surgical shock in an infant.

In view of these findings, the preferred technic in an infant would seem to be gastroenterostomy. In an adult, gastroenterostomy with transabdominal vagotomy is the procedure of choice. To our knowledge, gastroenterostomy with vagotomy heretofore had been performed on only one patient with annular pancreas, that reported by Warren [*28*]. This patient had complete relief of her symptoms at

the time of his report. If the annulus produces compression of the common bile duct and jaundice in an infant, chlecystoduodenostomy should be performed. Ascending cholangitis may occur later and require selective surgical procedures, since reflux cholangitis may be anticipated as long as the obstruction of the common duct persists. In the adult, obstructive jaundice due to compression of the common bile duct by the annulus may be treated the same way or a Roux-Y type of diversion of the common bile duct may be considered.

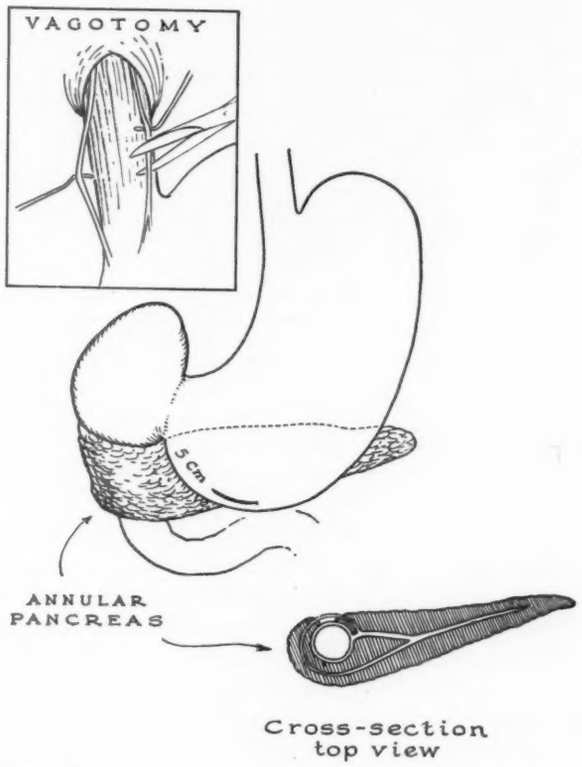

FIG. 1. The typical deformity of annular pancreas is depicted illustrating the more common arrangement of the duct system. The approximate site for antecolic gastroenterostomy is designated. The insert shows the importance of adequate mobilization of the esophagus when vagotomy is performed.

Two important steps in the performance of gastroenterostomy with vagotomy are illustrated. (Fig. 1.) The usual posterior gastroenterostomy rises to a higher level as gastric tone returns and dilatation is relieved. This frequently prevents the new stoma from functioning properly with consequent recurrence of the distal obstruction. The stoma should be placed at the greater curvature, about 5 cm. proximal to the pyloric sphincter. This placement prevents the retention of food in the pouch that forms between the usual high gastroenterostomy and the pyloric sphincter. Retention of food frequently acts as a stimulus for hypersecretion and hyperperistalsis (*vide supra*). An antecolic anastomosis is preferred, splitting or resecting part or all of the greater omentum. Occasionally the transverse colon is very redundant, in which case a retrocolic technic is employed. A small stoma functions better than a large one and, therefore, the stoma should not measure more than 2 to 2.5 cm. when completed. (Fig. 2.) Equally important is adequate mobilization of the esophagus for a distance of 8 to 10 cm. below the diaphragm in order to make certain that vagotomy has been complete.

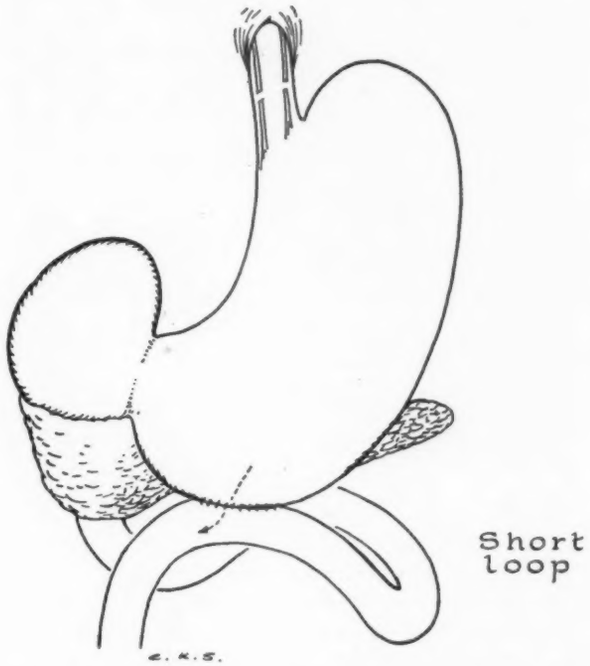

FIG. 2. Completed antecolic gastroenterostomy with vagotomy. The low anastomosis drains the stomach adequately and prevents the accumulation of food in the pylorus and proximal duodenum. Excessive stimulation of the hormone gastrin is thereby prevented with a concomitant rise in acid-pepsin.

CASE REPORTS

CASE 1. A sixty-six year old man was admitted to the hospital in May, 1951, because of postprandial epigastric distress and qualitative indigestion of ten years' duration. All laboratory studies were within normal limits. Complete roentgenographic studies of the gas-

FIG. 3. Case I. Photograph taken at the time of surgery shows annular pancreas covering approximately 75 per cent of the duodenum. The proximal dilated duodenum is retracted superiorly. Shock developed during mobilization of the duodenum and the abdomen was closed quickly. The patient refused further surgery.

FIG. 4. Case II. Dilatation of proximal and distal duodenum due to annular pancreas. A portion of the annulus was resected from the duodenal wall with difficulty and considerable blood loss. Duodenal obstruction was unrelieved following this procedure. Subsequent vagotomy and gastroenterostomy resulted in complete relief of symptoms.

trointestinal tract were normal except for the presence of a smooth filling defect in the outer portion of the descending duodenum "consistent with an extrinsic or intrinsic tumor." Exploratory laporatomy revealed a semiannular pancreas causing partial obstruction of the descending duodenum. (Fig. 3.) While the duodenum was being mobilized, shock developed and the incision was closed quickly. The symptoms still were present postoperatively, but the patient refused further treatment.

CASE II. A twenty-four year old man was admitted to the hospital on July 25, 1952, complaining of chronic indigestion, aggravated by a large meal, and progressive weight loss. Laboratory studies revealed moderate hypochlorhydria and a normal serum amylase. Gastrointestinal roentgenographic studies demonstrated a filling defect of the descending duodenum with moderate narrowing at the site of the defect. The roentgenographic impression was aberrant pancreas. At operation an annular pancreas was noted surrounding the second portion of the duodenum. (Fig. 4.) The proximal and distal duodenum was considerably dilated. A portion of the annular pancreas was resected with moderate difficulty and considerable blood loss. The patient's postoperative course was stormy and serum amylase values remained high for several weeks. Postoperative gastrointestinal roentgenographic studies showed no change in the previous filling defect and the symptoms were unabated. On April 25, 1955, the patient was readmitted to the hospital and gastroenterostomy and subdiaphragmatic vagotomy were performed. At the last follow-up examination on September 18, 1955, he had had no recurrence of his original symptoms.

CASE III. A fifty-nine year old man was admitted to the hospital in November, 1952, with a history of chronic indigestion and attacks of severe right upper abdominal pain for the past thirty-five years. He had been treated for disease of the gallbladder. The present attack of abdominal pain had begun eight hours prior to admission. Physical examination revealed findings suggestive of acute cholecystitis, with exquisite tenderness to pressure and rigidity of the muscles of the right upper abdominal wall. Laboratory studies revealed a leukocyte count of 14,000 per cubic millimeter, with 73 per cent polymorphonuclear cells and 23 per cent lymphocytes. The serum amylase was 126 units and a survey film of the abdomen was reported to be normal. A diagnosis of acute cholecystitis was made and specific treatment instituted. Because the abdominal pain increased in intensity with persistent vomiting, the patient was operated on five hours later. At operation an annular

pancreas was noted surrounding the second portion of the duodenum. This portion of the pancreas was hard and there was edema of the adjacent tissues. The proximal duodenum and stomach were enormously dilated. The right portion of the greater omentum was resected and antecolic isoperistaltic gastroenterostomy was performed. After the patient was discharged from the hospital, recheck gastrointestinal roentgenograms revealed a normally functioning stoma with only a small amount of barium leaving the stomach by way of the duodenum which appeared normal with no evidence of obstruction. The patient's condition did not improve. He refused further surgical treatment for the chronic relapsing pancreatitis and died two years later in another hospital with symptoms of obstructive jaundice and acute pancreatitis.

CASE IV. The patient, a fifty-seven year old man, was admitted to the hospital in July, 1953, with a history of repeated attacks of upper abdominal pain for the past two years, aggravated by drinking alcoholic beverages. At operation elsewhere one year previously, a "pancreatic tumor was found covering the descending duodenum." The tumor was considered "nonresectible" and the operation terminated. On the present admission, all laboratory studies were within normal limits except the serum amylase which was noted to be 420 units. Gastrointestinal roentgenographic studies revealed a constricting lesion in the descending duodenum, consistent with a diagnosis of annular pancreas. (Fig. 5.) At the time of surgery an annular pancreas was seen, the seat of chronic pancreatitis. Operative cholangiograms revealed a normal common bile duct entering the third portion of the duodenum. Posterior gastroenterostomy and subdiaphragmatic vagotomy were performed. At the last follow-up examination on July 23, 1955, he had had no recurrence of his previous symptoms.

CASE V. A thirty-four year old man, patient of Dr. W. T. Sweeny of Cleveland, was hospitalized in June, 1953, with a history of epigastric pain for twelve years, relieved by food. During the past several months the pain had become more severe and had been associated with nausea and aggravated by the intake of food or liquids. There was no palpable abdominal mass but moderate tenderness to deep

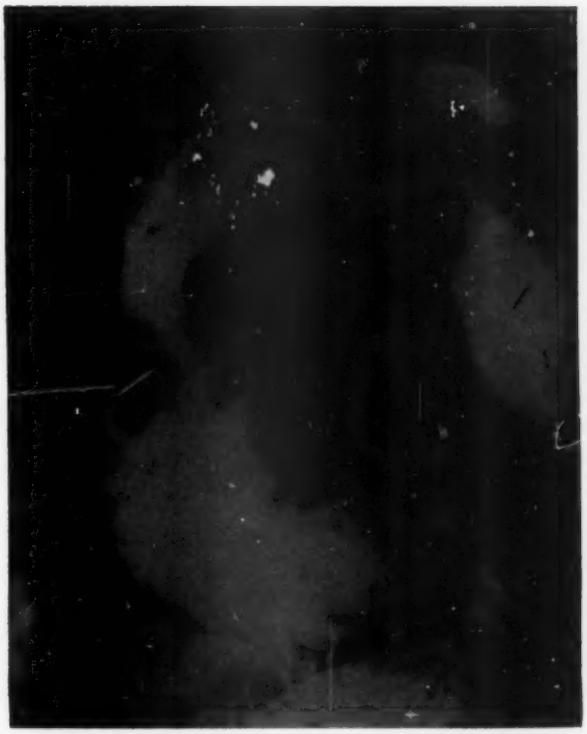

FIG. 5. Case IV. Oblique view of the duodenum depicting moderate constriction of second portion distal to the ampulla. Evidence of duodenitis involving the bulb and duodenum proximal to the constriction. At surgery an annular pancreas was found, the seat of chronic pancreatitis. The patient was completely relieved of symptoms following gastroenterostomy with vagotomy.

pressure was present in the right upper abdomen. Jaundice was absent and all laboratory studies were within normal limits, including a serum amylase value of 80 units. Roentgenographic and fluoroscopic studies of the upper gastrointestinal tract showed the stomach to contain a moderate amount of retained fluid. Moderate hypertrophic gastritis was present and the proximal duodenum was only slightly dilated near a smooth constriction of the second portion of the duodenum. (Fig. 6.) The diagnosis was annular pancreas. A biopsy specimen of the pancreas was taken and posterior gastroenterostomy was performed. The pathologic examination revealed pancreatic tissue with focal fibrosis and atrophy. At the time of the last follow-up on June 23, 1955, the patient had remained well. However, he must adhere to a rather strict diet in order to prevent recurrence of his previous symptoms.

CASE VI. A thirty year old woman was hospitalized in September, 1954, because of

FIG. 6. Case V. Right oblique view showing typical annular constriction of the second portion of the duodenum with dilatation of the bulb. Posterior gastroenterostomy was performed. Patient was relieved of obstructive symptoms but must adhere to a rather rigid diet. Low gastroenterostomy with vagotomy would be performed now (see text).

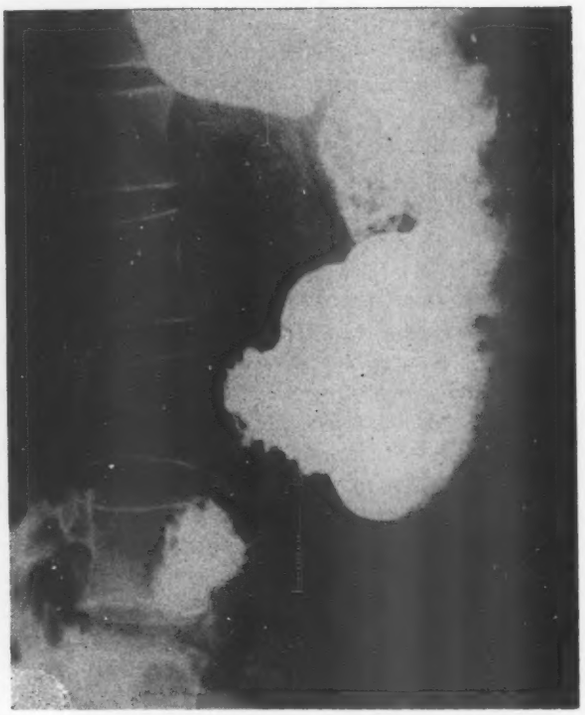

FIG. 7. Case VI. Lateral view of stomach and duodenum illustrating pronounced and abrupt constriction of the proximal portion of the descending limb of the duodenum. Low antecolic gastroenterostomy with vagotomy was performed. Symptoms were completely relieved for six months when severe hypoglycemia appeared, requiring subtotal pancreatectomy and splenectomy.

recurrent attacks of epigastric pain, nausea and vomiting, and progressive weight loss for the past eight years. An upper gastrointestinal roentgenographic series showed the esophagus and stomach to be normal. Reversed peristalsis was present in the duodenum proximal to a smooth constriction of the descending duodenum. There was no gastric retention. (Fig. 7.) A diagnosis was made of partial duodenal obstruction due to annular pancreas. Surgical exploration revealed an annular pancreas continuous with the head of the pancreas. The annulus covered approximately 80 per cent of the anterior duodenal wall to which it was intimately connected. An antecolic gastroenterostomy, resection of a portion of the greater omentum and vagotomy were performed. Recovery was complete for six months, when symptoms of hypoglycemia developed. A glucose tolerance test was performed. At the third hour, the patient became faint and then unconscious. The blood sugar content was 18 mg. per 100 ml. She was given dextrose intravenously and revived at once. Subtotal pancreatectomy and splenectomy were performed. Although no pancreatic adenoma was found, she has had complete relief from hypoglycemic attacks during the past year.

CASE VII. A thirty-nine year old woman, patient of Dr. M. E. Brickman of Cleveland, was hospitalized in April, 1955, with a history of chronic indigestion and periodic vomiting for the past ten years. She had lost 10 pounds (4.5 kg.) during the past six months. She had been advised to seek psychiatric consultation for her "functional complaints." All laboratory studies were essentially normal. Fluoroscopic and roentgenographic studies of the upper gastrointestinal tract revealed a dilated stomach containing food and fluid. The duodenal bulb was greatly dilated and reversed peristalsis was present. There was a smooth narrowing of the second portion of the duodenum with 75 per cent retention of barium in the stomach at the end of six hours. (Fig. 8.) A diagnosis was made

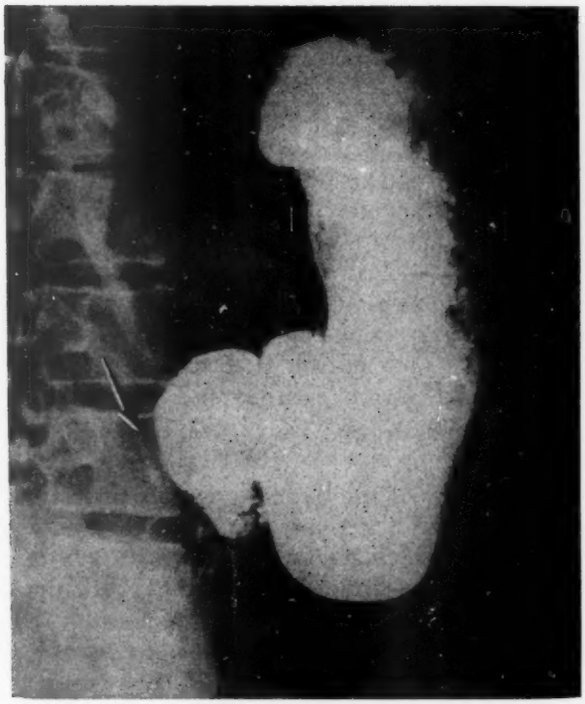

FIG. 8. Case VII. Oblique view of stomach and duodenum showing extreme dilatation of the bulb secondary to annular defect in the descending portion. The duodenum was mobilized and the annulus partially separated from the duodenal wall. A pancreatic fistula developed and the obstructive symptoms persist. Further surgery will be required.

FIG. 9. Case VIII. Lateral view of abdomen illustrating almost complete duodenal obstruction with pronounced dilatation of the stomach. Duodenojejunostomy was performed. The infant died and autopsy revealed persistent dilatation of the stomach.

of partial obstruction of the second portion of the duodenum due to annular pancreas. At the time of surgery an annular pancreas was found to surround the second portion of the duodenum completely. The annulus was continuous with the head of the pancreas and the duodenum was dilated to three times its normal diameter proximally. The duodenum was mobilized laterally and the annulus divided and partially separated from the duodenal wall to which it was intimately connected. Postoperatively a pancreatic fistula developed and drained for several months. The symptoms present prior to surgery were not relieved. Recheck gastrointestinal roentgenograms showed no appreciable improvement in the duodenal obstruction. Further surgery is contemplated soon.

CASE VIII. A five week old male infant, patient of Dr. F. T. Gallagher of Cleveland, was admitted to the hospital on August 25, 1955. Ten days after birth he had begun vomiting each feeding. Jaundice, which had been present during the first week, was slightly diminished. However, when admitted at the age of five weeks, there was persistent icterus of the scleras and skin. The infant weighed 4 pounds (1.8 kg.) compared with a birth weight of 5.2 pounds (2.4 kg.) Examination revealed distention of the upper abdomen, extreme dehydration with alkalosis, hemoconcentration and anemia. He was given thin barium by mouth and roentgenographic studies revealed "constriction of the descending duodenum, etiology undetermined." (Fig. 9.) After several days of preoperative preparation, abdominal exploration was performed and an annular pancreas was found constricting the descending duodenum. The proximal duodenum and stomach were greatly dilated and free bile-tinged fluid was present in the abdomen. A duodenojejunostomy was performed. The infant died two days later and autopsy confirmed the presence of an annular pancreas. The stomach was greatly dilated and bronchopneumonia was present. Examination of the heart revealed a patent foramen ovale and ductus arteriosus.

CONCLUSIONS

Annular pancreas probably exists with much greater frequency than the available literature would indicate. Increased diagnostic acumen will be facilitated by awareness that such an anomaly may be present and recognition of important diagnostic signs and symptoms. While many patients remain asymptomatic and their conditions are recognized only at postmortem examination, others show symptoms shortly after birth. Acute duodenal obstruction may be precipitated in later life by the onset of acute pancreatitis in the annulus. Two of our patients (Cases II and VII) demonstrate the inadequacy and danger of resection of the pancreatic ring of tissue. Very few patients in the cases reported have been relieved by this procedure, and similar complications of pancreatic fistula and persistent duodenal obstruction have been encountered. One of our patients (Case V) was treated by posterior gastroenterostomy. This patient must still adhere to a rigid diet in order to avoid digestive disturbance. Low antecolic gastroenterostomy would have drained the stomach more adequately and vagotomy would have reduced the secretion of acid-pepsin.

The presence of jaundice associated with obstruction of the descending portion of the duodenum is apt to be confusing. Differential diagnosis may be impossible prior to surgery. One of our patients (Case VIII), a premature infant with persistent vomiting due to annular obstruction of the duodenum, demonstrates this problem. Cholecystoenterostomy was considered, but the precarious condition of the infant after duodenojejunostomy had been completed necessitated termination of the operation. Although almost all authors advise duodenojejunostomy as the preferable type of by-pass procedure, several reports [7] indicate that the dilatation of the stomach may persist. This is especially true in infants, and our patient (Case VIII) showed persistent duodenal and gastric dilatation at postmortem examination.

It is our impression that a properly performed gastroenterostomy is preferable to any of the other surgical procedures recommended. The stomach is readily available and it would seem more logical to place the stoma at the pylorus, particularly when the stomach is dilated or shows evidence of gastritis or ulceration. The addition of vagotomy would be indicated in all adults because of the high incidence of peptic ulceration in the presence of obstruction near the pylorus. If pancreatitis is present, vagotomy may be valuable in reducing pancreatic secretion. One of our patients (Case III) demonstrates the frequent onset of acute pancreatitis in an annular pancreas that had produced chronic duodenal obstruction for a number of years, with symptoms suggestive of chronic relapsing pancreatitis. It is possible that the addition of vagotomy might have arrested the progressive pancreatitis that caused this patient's death several years later.

SUMMARY

Eight cases of annular pancreas are presented together with the operative findings in each case. Errors in diagnosis and treatment are discussed and certain diagnostic signs are presented. A satisfactory surgical technic is described and discussed. Symptomatic annular pancreas probably occurs with greater frequency than has been recognized or reported, and increased interest in this subject is evidenced by the number of case reports that have appeared during the past decade. This anomaly may be encountered unexpectedly at the time of surgery and the surgeon should be familiar with the pathology, complications and the various surgical procedures that have been recommended.

ADDENDUM

Since the completion of this paper for publication, we have operated on four additional patients with annular pancreas; all were treated by gastroenterostomy with vagotomy. In all cases a diagnosis of annular pancreas was made preoperatively by the characteristic roentgenographic findings.

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Cholelithiasis in the Negro Male

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CHOLELITHIASIS in the Negro male remains a rare pathologic entity, with no logical explanation for this fact up to the present time. Whether the cause is purely dietary or metabolic remains unknown.

In reviewing the statistics and the charts of Charity Hospital at New Orleans, Louisiana, we have found that the incidence of gallbladder disease in the Negro male has not changed noticeably despite more refined diagnostic methods over a period of twenty-five years (1930–1954).

During this twenty-five year period 1,415,775 patients were admitted to the Hospital, of which 631,745 were white and 784,030 were Negro. (Table 1.) It should be noted in Table 1 that in the earlier years the white patients outnumbered the Negro patients by a small mar-

TABLE I
TOTAL ADMISSIONS

Year*	White Patients		Negro Patients		Totals
	Male	Female	Male	Female	
1930–1934	72,587	77,318	46,787	58,060	254,752
1935–1939	82,557	88,878	57,654	76,819	305,908
1940–1944	52,308	58,295	57,278	87,146	255,027
1945–1949	45,771	50,314	63,551	111,232	270,868
1950–1954	49,291	54,426	79,670	145,833	329,220
Totals..	302,514	329,231	304,940	479,090	1,415,775

* Fiscal year July 1 to June 30 following year.

TABLE II
CHOLECYSTITIS

Year	White Patients		Negro Patients		Totals
1930–1937	2,415*		428*		2,843
	Male	*Female*	*Male*	*Female*	
1938–1942	164	1,484	27	465	2,140
1943–1947	146	1,328	45	114	1,633
1948–1952	229	1,182	91	474	1,976
1953–1954	105	375	40	329	849
Totals...	644	4,369	203	1,739	6,955
Total male and female patients..	5,013		1,942		
Total No. of patients..	7,428		2,370		

* Record room did not separate sexes.

TABLE III
CHOLELITHIASIS

Year	White Patients		Negro Patients		Totals
	Male	Female	Male	Female	
1930–1937	154*	.....	36*	...	190
1938	11	22	3	8	44
1939	13	25	2	7	47
1940	13	29	1	14	57
1941	14	58	1	16	89
1942	4	24	5	7	40
1943	11	44	4	20	79
1944	21	49	3	27	100
1945	11	32	3	18	64
1946	16	72	6	36	130
1947	22	84	3	51	160
1948	12	79	7	43	141
1949	19	96	9	28	152
1950	14	115	13	42	184
1951	29	65	7	33	134
1952	20	122	17	66	225
1953	35	161	25	104	325
1954	39	132	12	120	303
Totals...	458	1,209	157	640	2,464

* Record room did not separate sexes. Authors have separated males for this period.

gin. However, in more recent years this has changed so that in present admissions Negro patients outnumber white patients over two to one.

According to the records, cases of cholecystitis totaled 9,798 from 1930 to 1954. Of this number there were 7,428 white patients and 2,370 Negro patients. Of this large group only 203 cases were in the Negro male. (Table II.) It will be noted in Table II that along with the increased Negro population in the Hospital there has also been a slight, but progressive, increase in the incidence of cholecystitis in the Negro male. The incidence of cholecystitis in the Negro female has remained the same.

Because we were unable to separate sex and race by the Card Index System from 1930 to 1937, it was necessary to review the individual charts for this period. As we were primarily interested in males with gallstones, these were the persons we studied. In the period from 1930 through 1937 there were 154 white males and thirty-six Negro males with gallstones. From 1938 through 1954 there were 304 white males and 121 Negro males. From 1930 through 1954 the total number of white males was 458, and Negro males 157. (Table III.)

TABLE IV
CHOLELITHIASIS IN THE NEGRO MALE
(NUMBER OF PATIENTS PER YEAR)*

Year	No. of Patients	Operation	Autopsy	Roentgenographic Study
1930	2	2	0	..
1931	1	1	0	..
1932	0	0	0	..
1933	4	3	1	..
1934	2	2	0	..
1935	3	3	0	..
1936	2	1	1	..
1937	3	2	1	..
1938	1	0	1	..
1939	1	1	0	..
1940	2	1	1	..
1941	2	0	2	..
1942	4	1	3	..
1943	4	1	3	..
1944	4	4	0	..
1945	3	0	3	..
1946	3	1	2	..
1947	2	2	0	..
1948	4	3	1	..
1949	5	2	3	..
1950	5	5	0	..
1951	7	3	3	1
1952	8	6	1	1
1953	15	8	7	..
1954	10	9	1	..
July 1, 1955	7	5	0	2
Totals.....	104	66	34	4

* Hospital records are from July, 1930, through June, 1955.

TABLE V
CHOLELITHIASIS
(NUMBER OF PATIENTS IN RELATION TO AGE)

Age (yr.)	Operation	Autopsy	Roentgenographic Study
10–29	9	0	0
30–39	10	3	0
40–49	13	4	1
50–59	19	8	3
60–69	8	6	0
70–79	7	10	0
80–89	0	3	0
Totals..	66	34	4

In reviewing the 157 charts of the Negro males we accepted only roentgenographic, operative or autopsy diagnosis of gallstones. It was then necessary to delete fifty-three cases for lack of any confirmation of gallstones except someone's "clinical impression." This left a total of 104 substantiated cases of gallstones in Negro male patients. Sixty-six cases were proved at surgery, thirty-four were proved at autopsy and four were confirmed by roentgenographic studies. (Tables IV and V.) This would give an incidence of 0.034 per cent of all Negro male patients admitted from 1930 through 1954. The majority of these patients were between the ages of thirty and sixty years. If one compares the number of Negro males who had cholelithiasis with the total male admissions over this period, the incidence of gallstones in the Negro male is 0.007 per cent.

The complications of cholelithiasis and associated diseases in the Negro male are tabulated in Table VI. It is interesting to note that of the 104 cases there were fourteen cases of carcinoma of various organs, three of which were primary in the gallbladder. This would be an incidence of 2.9 per cent of carcinoma of the gallbladder in the Negro male with gallstones.

TABLE VI

CHOLELITHIASIS AND ASSOCIATED DISEASES

Age Groups (yr.)	Operation	Autopsy	Roentgenographic Study
10–29	Common duct stone (1); empyema of gallbladder (1)*	Empyema of gallbladder (1)	.....
30–39	Acute pancreatitis (1)	Pulmonary embolus (1); cerebral vascular disease (1)	.....
40–49	Leiomyoma of stomach (1); hemothorax (1); empyema of gallbladder (1); common duct stones (3); chronic pancreatis (1); adenocarcinoma of ampulla of Vater (1); hydrops of gallbladder (1); carcinoma of gallbladder (1)	Hepatic cirrhosis (1); intestinal obstruction (stab wound of abdomen) (1); syphilitic heart disease (1); pneumonia (2); infarct of lung (1)	Ileus (1)
50–59	Gastric polyposis and empyema of gallbladder (1); volvulus (1); duodenal ulcer (1); chronic pancreatitis (1); empyema of gallbladder (1); carcinoma of cecum (1); hepatic abscess (1); hydrops of gallbladder (1)	Hepatic cirrhosis and thoracic aneurysm (1); cerebral vascular disease (1); carcinoma of rectum (1); hydrops of gallbladder (1); empyema of gallbladder and carcinoma of urinary bladder (1); pulmonary tuberculosis (1); hepatic abscess and common duct stones (1); pulmonary abscess (1); carcinoma of gallbladder (1)	.....
60–69	Adenocarcinoma of gallbladder (1)	Bronchopneumonia (2); diaphragmatic hernia (1); hepatic and nephritic abscess (1); bronchogenic carcinoma (1)	.....
70–79	Empyema of gallbladder (1); carcinoma of prostate (1); carcinoma of ampulla of Vater (1)	Adenocarcinoma of prostate (2); cerebral hemorrhage (1); cavernous hemangioma of liver (1); acute hemorrhagic pancreatitis (2); carcinoma of stomach (1); gastric ulcer (1); empyema of gallbladder and thoracic empyema (1); bronchogenic carcinoma (1)	.....
80–89	.....	Tuberculous peritonitis (1); prostatic hypertrophy (1)	.....

* Figures in parentheses represent the number of patients.

The acceptable incidence of carcinoma of the gallbladder found at operation is approximately 1 per cent when the clinical diagnosis is cholecystitis. In the presence of gallstones the incidence is between 4 and 5 per cent [4]. According to Judd, as quoted by Ackerman and del Regato [4], 65 per cent of the cases of carcinoma of the gallbladder are associated with stones, while Janowaski [4] reports 100 per cent incidence of stones associated with carcinoma of the gallbladder.

Only four cases of common duct stone were found. One patient, aged sixty-two years had perforation of the gallbladder.

In reviewing the literature, all the previous reports have been based on autopsy statistics. On this basis the incidence of gallstones in the Negro male has ranged from 3.25 per cent (Lieber [1]) to 3.04 per cent (Ludlow [2]).

As was pointed out by one of the authors (E. B.) in a previous article [3], the incidence of appendicitis in the Negro male, once rare, is now common, but the incidence of gallstones remains rare.

CONCLUSION

1. Cholelithiasis in the Negro male remains a rare disease, comprising 0.007 per cent of admissions of Negro male patients to Charity Hospital at New Orleans, Louisiana.

2. No satisfactory explanation for the rarity of the disease is known at this time.

3. Cholecystitis in the Negro male is in-

creasing. Cholecystitis in the Negro female remains the same.

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We recommend:

Pott's Paraplegia. By D. L. Griffiths, M.D., H. J. Sedgon, M.D. and R. Roaf, M.D. 129 pages, with a few illustrations and an index. New York, 1956. Oxford University Press. *Price* $12.75.

Fractures of the Facial Skeleton. By N. L. Rowe, M.R.C.S. (Eng.) and H. C. Killey, F.D.S.R.C.S. (Eng.). Foreword by Sir Reginald Watson-Jones. 923 pages with 1,231 illustrations, 14 in full color. Baltimore, 1956. Williams & Wilkins Co. *Price* $22.00.

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Vaginal Plastic Surgery Based on a New Concept of the Anatomy of the Female Genital Tract

II. BIRTH INJURIES TO THE UPPER VAGINA*

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THE extent of birth injuries to the upper vagina varies. They may be so slight as to be hardly recognizable, but they are present in almost every parous woman.

In the full development of such injuries, the vagina is shallow and wide open; and the cervix is large, heavy and edematous, presenting near the orifice of the vagina. Behind the cervix is a distorted shapeless mass of vaginal wall, hanging loose from the posterior lip of the cervix.

Etiologically and pathologically, this condition is the exact counterpart of the birth injury occurring anterior to the cervix, to which attention was called in the previous article on this subject [*1*] and which had been designated as the avulsion of the anterior vaginal wall. The condition now under consideration, however, is more extensive and more complicated, and has a more profound effect on the well-being of the patient.

To appreciate properly the development of this condition, it is necessary to refer to the normal anatomy of this part of the genital tract, as was described in the aforementioned article. It was emphasized therein that the vaginal wall, posterior to the cervix, extends under the expanding part of the uterus, above the cervix, and thus forms the posterior fornix. The vaginal wall then ascends along the posterior surface of the lower part of the uterus to a point slightly above the level of the sacrouterine ligaments. The vault of the vagina is thus formed. The anterior part of the vault is, however, firmly attached to the uterus. The rest of the vault is attached to the overlying pelvic fascia, which is rather firm and dense in this area.

In difficult and prolonged labor, the vault of the vagina may be torn away from its normal attachment; in other words, there is an avulsion of the vault from the uterus, analogous to the avulsion of the anterior vaginal wall from the pubis. There follows, then, a sliding down of the vault and more of the posterior vaginal wall, which is now visible, hanging loose from the posterior lip of the cervix, as noted previously.

The cervix, dragged down by the vaginal wall, may simulate a moderate descensus or first degree prolapse of the uterus, but this may not be the case at all. Incidentally, the cervix, while appearing hypertrophied, is probably more edematous than hypertrophied, due to its unnatural position and interference with its lymphatic drainage.

SURGICAL TREATMENT OF AVULSION OF THE VAULT OF THE VAGINA

Free and wide exposure of the entire operative field is of the utmost importance in the approach to the treatment of this lesion, because certain parts naturally placed at a higher level may not be otherwise accessible. Therefore, a deliberate median perineotomy is an absolute requirement as the first step of the operative procedure. This will not only provide abundant room to work in but also will avoid the use of the troublesome, weighted speculum which occasionally slips out and down at the most inopportune moment. Instead of the speculum, a suture or an Allis clamp holds the flaps of the perineum apart, and good exposure is obtained. Perineotomy will also minimize the use of any other retractors, and this will be appreciated by the surgical

* Part I appeared in the May 1957 issue of *The American Journal of Surgery*.

assistants who are obliged to assume most uncomfortable positions while holding retractors. Good light is, of course, most essential.

Operative Technic. The cervix is grasped with a tenaculum and pulled up toward the arch of the pubis. At the same time, as traction is made on the perineal flaps by the assistants, the posterior vaginal wall is completely straightened. A median incision is then made through the vaginal mucosa and musculature, beginning at the cervix and continuing as far down as may be indicated. If pelvic fascia is visualized, this is likewise incised up to the peritoneal coat. Should the peritoneum be inadvertently opened, no harm is done. In fact, it may be advantageous and may even be done intentionally, in order to explore the pelvic organs. This may also reveal an enterocele, if one is present.

With so great a descent of the upper vagina, an enterocele is probably a frequent concomitant (see section on enterocele).

The peritoneum, which is rather loose in this area, is stripped up to above the level of the sacrouterine ligaments. If the peritoneum is adherent to the uterus and cannot be stripped up, it does not matter, as the sutures to be described may include the peritoneal coat. The surface of the lower part of the uterus is now fully exposed, and the reconstruction of the vault of the vagina can be readily undertaken. This is accomplished as follows:

With a silk suture in a small full curve needle, a bite is taken through the musculature in the lowest part of the uterus, just above the cervix, and then through the lateral vaginal flap on one side, taking in fascia and muscle but not mucosa. A clamp holds the suture. A similar suture is applied to the vaginal flap on the other side. Ascending up the uterus, similar sutures are applied between the uterus and the vaginal flap on each side. The sutures are pulled up to observe the effect on the position of the cervix. While the peritoneum is open, the sacrouterine ligaments may be shortened, which will pull the cervix upward and backward.

It may now be observed that a cupola-like structure has been formed. In other words, the vault of the vagina has been reconstructed. Before the sutures are tied, the peritoneum is closed by continuous everting sutures, the same as in the closing of an abdominal incision. The sutures are then tied, and a number of interrupted, submucous sutures are used to bring the vaginal flaps together in the median line. Finally, a continuous suture closes the vaginal wound. The operation for avulsion of the vault of the vagina is thus completed.

The repair of the perineotomy will be discussed in a future paper on perineorrhaphy.

THE ENTEROCELE AND THE DEEP CUL-DE-SAC OF DOUGLAS

These are two distinct entities and should not be confused. The enterocele conveys the idea of a hernia and a sac. The cul-de-sac of Douglas is a natural anatomic space varying in depth within certain limits. But, under certain abnormal conditions, such as increased intra-abdominal pressure, or in a birth injury when the vagina may become separated from the rectum, the pelvic peritoneum may be stretched to the extent that in extreme cases it may reach almost to the skin and be a source of discomfort to the patient.

With reference to the enterocele, an observation reported by Meigs may be of great significance. He found, during abdominopelvic operations, a definite depression in the pelvic peritoneum between the sacrouterine ligaments and behind the uterus. Now, it is conceivable that in cases of avulsion of the vault of the vagina, as has been discussed previously, as the vaginal wall slides down, the peritoneum between the ligaments may be dragged down with it and actually form the sac of an enterocele. Such an enterocele may be the source of great danger if a loop of bowel or the omentum finds its way into it and becomes incarcerated, as has actually been reported in the literature. This is not likely to occur even in an extremely deep cul-de-sac of Douglas, except, perhaps, in pelvic inflammatory conditions when loops of bowel or the omentum become adherent, causing intestinal obstruction.

The treatment of either of these conditions, it should be recognized, is entirely different.

Surgical Treatment of the Enterocele. If, during an abdominal operation, the enterocele is encountered, the deep part of the enterocele may be picked up with an Allis clamp and everted into the peritoneal cavity. The redundant tissue is amputated and the neck sutured, as is done in the case of an inguinal hernia. A similar procedure may be followed during a vaginal operation, for example, during operation for avulsion of the vault when the

pelvic peritoneum has been opened. Also, the same treatment may be applied when the enterocele has been recognized and is accessible. It should be realized, however, that in either case the excision of the sac alone would not prevent the recurrence of such an enterocele, any more than would excision of an inguinal sac alone prevent the recurrence of the inguinal hernia. A supporting structure must be provided; in the case of an inguinal hernia this is accomplished by the repair of the abdominal wall.

In the case of an enterocele, this may be taken care of by bringing together the sacrouterine ligaments by a suture in the median line. This will give support to the sutured peritoneum, and thus form a barrier against the recurrence of the enterocele. Incidentally, the same treatment may be applied when the depression referred to by Meigs is observed during an abdominal operation, in the absence of an enterocele; this will prevent the possible development of a future enterocele.

Treatment of the Deep Cul-de-Sac of Douglas. If treatment is indicated, there are two methods available:

1. If operating abdominally, the Moschcovitz procedure for prolapse of the rectum is readily applicable and should prove very effective. This consists of taking a number of circular sutures in the cul-de-sac of Douglas and bringing the vaginal and rectal walls together, thereby completely obliterating the cul-de-sac. This procedure would be more difficult by the vaginal route, although it could be done.

2. This method is usually described in textbooks. During a vaginal operation when the cul-de-sac of Douglas is encountered, the peritoneum is stripped up, the redundant tissue is excised and the opening in the pelvic peritoneum is closed with a suture. However, that alone, as in the case of the enterocele, will not prevent its reformation and the sacrouterine ligaments should be sutured, as indicated previously. Furthermore, if the space between the vagina and the rectum is not obliterated, serous fluid is quite likely to accumulate in this space and, due to the proximity of the rectum, may even result in an abscess. In order to prevent such a complication it is necessary to bring the vaginal and rectal walls together by a number of interrupted sutures.

The choice of procedure must be determined by the operating surgeon.

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A Combined Two-team Technic in the Surgical Treatment of Varicose Veins

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IN an endeavor to constantly improve our end results in the treatment of varicose veins of the lower extremity, we have employed several methods. At the present time, in our opinion, high saphenous vein ligation plus stripping of the vein from the fossa ovalis to the ankle, with ligation of the communicating veins by multiple incisions, seems to be the most satisfactory surgical procedure.

This procedure is tedious, exacting and time-consuming. Several hours are often required for the operation, depending on its thoroughness. For this reason, in an effort to shorten the operating time, we have adopted high saphenous vein ligation and stripping using a two-team technic, performing unilateral rather than bilateral ligation at a single operative period. This procedure has proved gratifying, both from the standpoint of the patient and the surgeon.

In 1908, Friedel [1] excised the greater saphenous vein from the groin to the foot, an operation used by many surgeons over a period of years. The senior author, in 1929, also employed this procedure bilaterally, but although results were good, prolonged postoperative morbidity discouraged his further use of the method.

The first stripping operation for varicosities of the lower extremity was reported by Keller [2] in 1905.

In 1906, Mayo [3] developed an extraluminal stripper, a long rigid rod with a ring attached.

The trend toward the stripping technic continued, but up to the past six or seven years many stripping operations were inadequate, with the veins stripped down from the thigh but only to the knee. From greater experience with the stripping technic, the more complete operation was evolved. With the present procedure also most every varicose vein is removed by stripping from the ankle to the groin, with ligation of all branches, together with multiple ligation of all communicating branches.

For the past thirty years the senior author has had an excellent opportunity to personally witness the evolution and marked advance of therapy for varicose veins, with an increasing trend today toward surgical treatment. His broad experience and that of his associates in the treatment of varicose veins has covered five phases: (1) the injection of a sclerosing solution which was the first method used by the senior author; (2) high saphenous vein ligation, dissecting and ligating the branches at the fossa ovalis; (3) high saphenous vein ligation with complete resection at the fossa ovalis, plus injection of a sclerosing solution with a rubber urethral catheter into the distal stump of the saphenous vein; (4) high saphenous vein ligation and phlebectomy with the aid of a malleable intraluminal guide [4]; and (5) high saphenous vein ligation plus stripping of the vein from the fossa ovalis to the ankle, with ligation of the communicating veins by multiple incisions. This last technic is the operation of choice of the authors, now enhanced by the two-team procedure which will be described.

EVALUATION OF THE PATIENT

The primary factors in successful treatment of varicose veins of the lower extremity are determination of the competency of the deep circulation, including that of the perforating branches from the ankle to the groin; obtaining

FIG. 1. Two-team approach to varicose vein surgery.

a history of the patient and determining that no contraindicating pathologic condition exists; and a careful scrutinizing examination of the involved leg for detection of "blow-outs," stasis changes, sites of valvular incompetence and other local disorders.

Various diagnostic tests are devised and used for determining the patency of the deep veins and/or valvular incompetence such as the Perthes, Trendelenburg, Mahorner-Ochsner tests and others. Opinions differ to some extent as to the relative values of the more commonly used testing procedures. We employ and prefer the Perthes test for investigating the competency of the deep venous circulation, combined with the Mahorner-Ochsner test for determining the incompetency of the various perforating veins if present.

If these tests do not clearly demonstrate the adequacy of the deep venous circulation, we apply a snug-fitting bandage from the ankle to the knee for several days. If the patient complains of no discomfort, the deep circulation is adequate. On the other hand, if the patient complains of pain and swelling, it is evident that the deep circulation is inadequate.

However, experience has shown that very few patients have to be refused surgery because of incompetent deep venous circulation.

TWO-TEAM TECHNIC

The varicosities are usually marked the day previous to or the day of operation with a pyrogallic acid solution described by Myers [5]. We prefer this solution because it is not affected by vigorous scrubbing of the leg, and in our experience has caused no irritation or other untoward effect.

The patient is placed on the operating table and a sandbag is placed under the slightly flexed knee. This allows the femoral triangle to be outlined. The fossa ovalis is at the apex of this triangle. The entire shaved leg, including the lower abdomen, is scrubbed with soap and water. The patient is draped, leaving the lower extremity exposed from the groin to the ankle.

General anesthesia with sodium pentothal® induction is most commonly used. Spinal anesthesia is used occasionally when indicated.

For the two-team procedure (Fig. 1), we use the technic of high saphenous vein ligation and stripping described herein,* and employ the Myers [7] or the Linton modification of the Williams stripper [8].

Team Number 1 makes an incision in the groin, parallel to Poupart's ligament, over the apex of the femoral triangle and down to the deep layer of the superficial fascia. This fascia is cut longitudinally and the greater saphenous vein is dissected free. Two clamps are placed upon it and the vein is divided. Dissection is continued downward to the medial femoral cutaneous vein which is usually found, and this vein is cut and ligated with No. 00 chromic

* This technic has been previously reported and illustrated [6].

catgut, which is the suture material we are using at present. Cotton, however, is a good suture material to use in this operation and was used by the senior author for several years.

The proximal end of the greater saphenous vein is followed to the saphenofemoral junction by careful dissection. All tributaries are individually clamped, cut and ligated. In our experience we have noted that many variations exist in the venous pattern in the region of the fossa ovalis. The most commonly encountered veins are the superficial external pudendal, superficial epigastric, superficial iliac circumflex and occasionally the lateral femoral cutaneous.

The saphenous vein is now doubly ligated flush with the femoral vein, with No. 0 chromic catgut, the distal end being transfixed with a suture ligature. The excess vein is excised. The fossa ovalis is closed with a purse-string suture.

The hemostat on the distal end of the vein is rotated 180 degrees and an incision is made into the lumen of the vein over the hemostat. The stripper is then placed down the lumen of the vein until obstruction is met. It may proceed unhampered down the entire length of the vein to the medial aspect of the ankle. Rather than stripping the entire length of the vein and breaking the communicating branches, we prefer to make an incision above the knee over the stripper because not infrequently a large communicating vein can be found at this point, pick up the greater saphenous vein and dissect, sever and ligate any communicating veins, and doubly clamp and sever the greater saphenous vein. The proximal hemostat is released and the olive tip of the stripper is allowed to extend through the lumen. The proximal segment of the vein is doubly ligated on the stripper with a long piece of catgut and then with about 18 inches of silk suture. The sutures are left long so the vein can be traced out to the lower incision in case it breaks while being stripped upward. In such a case the vein can be tied over the stripper at its proximal end and then stripped downward. The stripper is pulled upward while pressure is applied over the skin of the medial surface of the thigh. If a large communicating vein is found, resistance will be encountered and the communicating vein is ligated through a separate skin incision if large, or pulled off if small. The vein, having been turned inside out, is removed with the stripper from the incision in the groin. The stripper is then placed in the distal segment of vein and passed to below the knee.

Team Number 2 has simultaneously made a longitudinal incision at a point equidistant from the medial malleolus, and the midline of the dorsum of the foot and the saphenous vein is isolated, clamped and cut. The distal end is then explored for the medial vein or other tributaries which are individually clamped, cut and ligated. The vein is incised and a stripper is placed in the proximal end and inserted upward in the saphenous vein to just below the knee, where an oblique incision is made and the vein is stripped upward from the ankle to below the knee. Usually about three or four deep perforating veins are separately ligated through small incisions in the skin between the ankle and knee.

The intervening segment of vein above and below the knee is then stripped out, either by Team Number 1 from above down, or by Team Number 2 from below up, thus completing the stripping from the ankle to the groin. Many times the stripper will follow the course of the vein to above the knee or even to the groin. When this occurs, the procedure is simplified.

Recently we have turned more attention to the surgical treatment of the lesser saphenous vein. (Fig. 2.) Varicose ulcers or stasis dermatitis on the lateral surface of the leg may require surgical attack. The technic in lesser saphenous vein ligation is to make an incision on the lateral surface, equidistant between the external malleolus and the Achilles tendon. The lesser saphenous vein is isolated, the distal end clamped, cut and ligated, and the proximal end incised as in the procedure for the greater saphenous vein. In ligating the lesser saphenous vein near the ankle, care must be taken not to injure the sural nerve which runs parallel and adjacent to the lesser saphenous vein at this site. A stripper is placed in the lumen and moved upward to near the saphenopopliteal junction in the lower popliteal space between the heads of the gastrocnemius muscle. A transverse incision is made here, and the lesser saphenous vein is picked up. The stripper is brought out through the open cut end, the proximal end is ligated and the distal segment is stripped from the ankle to below the knee. The wound is closed and pressure bandages are applied.

Incisions are closed with No. 00 plain catgut

for the subcutaneous tissue. Interrupted black silk suture cut about 1 inch long to facilitate removal is used for the skin. An elastic adhesive bandage is applied from the foot to the groin after small sterile dressings have been placed over the incisions.

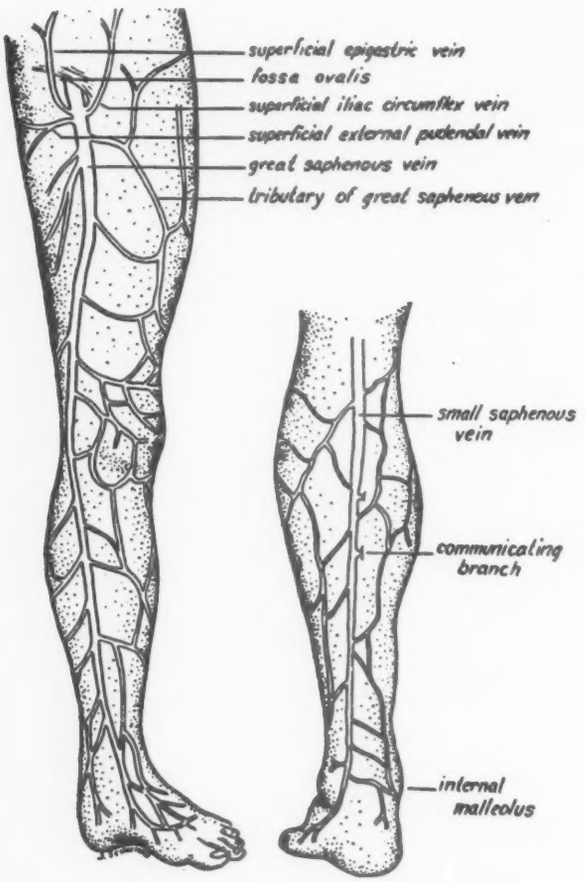

FIG. 2. Superficial venous system of the lower extremity.

If a varicose ulcer is present, a zinc oxide–impregnated bandage is applied, a large piece of gauze is placed over it and this is reinforced by an elastic adhesive bandage. Presence of a varicose ulcer does not deter us from performing high saphenous vein ligation and stripping, if no cellulitis is present. The ulcer will often heal quickly after ligation and stripping of the vein because with venous return in this area improved, more oxygenated arterial blood is allowed to enter the ulcer area, facilitating healing of the ulcer.

Patients are ambulant after anesthesia wears off and are usually discharged from the hospital on the second or third postoperative day, although some prefer to remain longer. Stitches are removed on the seventh postoperative day if the incisions are well healed. If not, every other silk suture is removed and the wound is redressed. Prominent superficial veins, if present, are injected with a sclerosing solution at this time, and an elastic bandage is applied from the toes to the knee. After the wounds are healed and the superficial veins injected, the patient is discharged but is instructed to return in six months for a check-up and injection of any residual, recurrent, or newly formed or developing superficial veins.

ADVANTAGES OF TWO-TEAM TECHNIC

The two-team procedure described, similar to the two-team technic sometimes used in combined abdominoperineal resections, has several advantages. First, as mentioned previously, operations for varicosities of the lower extremity often consume as many as one to three hours. This, of course, is dependent in great part upon the number of communicating and perforating veins present and the thoroughness of operation.

With two teams operating simultaneously and performing high saphenous vein ligation and stripping unilaterally rather than bilaterally at one operation, the period of anesthesia is understandably reduced. In many instances, this is invaluable from the patient's standpoint. At the same time, we have found that with the operating time greatly shortened, the operators' strength is conserved.

Our results with this procedure have been gratifying, and postoperative complications, morbidity and mortality have been negligible.

COMMENTS

This discussion has concerned itself solely with surgical treatment of varicose veins of the lower extremity, and specifically with a two-team procedure of operation. Obliteration of varicose veins by injection therapy, the merits and disadvantages of various sclerosing agents, and the indications and contraindications to the stripping operation which have been well covered in the literature have not been included.

In our experience, injection treatment of varicose veins has not been satisfactory because of the high incidence of recurrences and the poor results caused by recanalization of the thrombosed vein. At present very few of our patients are treated by injection alone. An occasional patient in whom the veins do not appear large

enough to warrant ligation and stripping is treated by injection.

It is our practice to ligate the saphenous vein at the saphenofemoral junction (fossa ovalis) even when tests fail to show incompetence of the saphenofemoral valve but simply reveal incompetence of the deep communicators in order to rule out the possibility of the saphenofemoral valve breaking down later and causing dilation of the remaining distal vein.

It may be well to point out that very often we make the original incision at the ankle and pass the stripper from the ankle to the groin. This seems to be a good procedure when the patient has had previous ligation in the groin, and it facilitates finding the saphenous vein in that location. Often the saphenous vein proper had never been ligated at a previous operation, but instead large branches which had been mistaken for the greater saphenous vein. With the present procedure of extensive stripping and dissection at the fossa ovalis, enhanced by two teams working simultaneously, this is not likely to occur.

SUMMARY AND CONCLUSIONS

A two-team technic of high saphenous vein ligation unilaterally plus stripping of the vein from the fossa ovalis to the ankle, with ligation of the communicating veins by multiple incisions, is described.

The chief merits and advantages of the two-team procedure are a shortened period of anesthesia for the patient and conservation of the operators' strength.

We have emphasized our opinion that surgical removal of varicose veins is detailed and meticulous. For this reason, we believe that radical stripping and dissection of varicose veins from the fossa ovalis to the ankle, with ligation of all communicating veins by multiple incisions, has, in our experience, been the most satisfactory procedure to date. This operation, performed by two teams operating simultaneously, should prove a valuable addition to the armamentarium of those interested in the field of surgery for varicose veins.

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The Prevention of Postoperative Shock and Postanesthesia Hypotension by Use of the Reverse Trendelenburg Position during Surgery under Light, Etherless, General Anesthesia

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AMONG anesthesiologists and surgeons there is unanimity of opinion regarding the disadvantages and stress which several awkward surgical positions, such as Trendelenburg, lithotomy, face-down and even supine, impose upon the cardiorespiratory systems of anesthetized patients.

An example of the imposition of a major strain on these systems could be observed during a Miles abdominoperineal resection, perineal prostatectomy and vaginal hysterectomy. During these operations the patient usually appears to be in good condition, but an abrupt change frequently occurs when the legs are removed from the stirrups and placed flat on the operating table while at the same time the table is changed from the Trendelenburg to the horizontal position. It is not unusual to observe a sudden or a gradual fall in blood pressure, sudoresis and shock.

Another example of unusual stress is that observed when the patient has been in the Trendelenburg position for gynecologic or pelvic surgery for a long period. Hypotension bordering on shock is frequently seen at the termination of this type of surgery, and it usually occurs shortly after the table is leveled to the horizontal position, when the patient is moved onto the litter or shortly after the patient arrives in the bedroom or recovery room. In both examples this complication does not usually occur until after the anesthesia mask has been removed.

This syndrome, furthermore, is not limited only to closed system ether or cyclopropane anesthesia even though, according to Dripps [*1*], it may occur more frequently with closed anesthesia methods, especially when respiration is not adequately assisted. It may and does occur as a concomitant of any type of general anesthesia during which the Trendelenburg position has been steep and prolonged or the legs have been suspended in stirrups for prolonged periods of time.

Why does hypotension or shock occur when patients are placed in a horizontal position after the stress of prolonged Trendelenburg or lithotomy position, and after removal of the anesthetic mask, and how can this syndrome be prevented? The answer to this question involves a complex multitude of factors which can be referred to as a generalized interference with the normal dynamics of circulation and respiration. Some of the following factors are probably involved in this phenomenon:

1. Relaxation of the blood pressure–regulating mechanisms due to the fact that gravity helps maintain blood pressure while the patient is in the Trendelenburg position. Theoretically the pressor regulators may, therefore, be somewhat inactive during the Trendelenburg episode since their efforts are temporarily not being fully employed. As a consequence, there may be a delay in their compensatory response when called upon to re-establish the main-

tenance of normal blood pressure, especially if oxygen tension is suddenly decreased to normal atmospheric oxygen simultaneously with leveling the table to the horizontal position. This occurs at the termination of anesthesia and surgery, when performed with the patient in the Trendelenburg position.

The term blood pressure–regulating mechanisms refer to the pressor and depressor effects evoked by decreased and increased arterial pressures in the arch of the aorta and carotid sinuses. There is good evidence [2] that when a relaxed human being is changed from a horizontal to a head-up, feet-down (reverse Trendelenburg*) position, there is a momentary fall in arterial pressure due to the effect of gravity on the venous return with its consequent effect on cardiac output. Compensation is effected in the normal person by the effect (reflex vasoconstriction) of lowered pressures in the aorta and carotid sinuses. The dependence of the compensation on this reflex effect has been shown in experiments in dogs [3]. It is possible that when patients are restored to the horizontal position there may be some effect of gravity directly on pressure within the large arteries, but the effect is probably greater upon venous pressures and flows. In the Trendelenburg position venous return to the right heart should be relatively enhanced. On return to the horizontal position it would be relatively decreased, and this might lower arterial pressure because of the consequent decrease in cardiac output. If there had been much loss of blood, this effect would be relatively greater.

On the other hand, if excessive trauma or blood loss occurs in a patient in reverse Trendelenburg or head-up position, hypotension or a tendency toward shock usually becomes apparent very quickly on the operating table and soon enough to initiate effectively prophylaxis such as blood, glucose and a repositioning of the table to the level or even slight Trendelenburg position until the hypotension is corrected. Hypotension caused by hemorrhage or excessive trauma is difficult to mask or hide while the patient is in the reverse Trendelenburg position since the force of gravity is not available to aid the body in maintaining a higher pressure. The patient who maintains a normal pressure during surgery in the head-up position does so because of the integrity of his system, and one can predict with amazing accuracy that so long as blood pressure remains normal in this position it will not fall to shock levels in the immediate postoperative period, regardless of how roughly the patient may inadvertently be moved in transit from the operating room to his bedroom.

2. Trendelenburg position interferes with respiratory amplitude since the abdominal contents tend to slide upward toward the diaphragm and exert the pressure of their weight against it. Abdominal viscera are further impacted against the diaphragm by packs and towels which further compounds this already strained position. Decreased respiratory amplitude interferes eventually with cardiac output, elimination of carbon dioxide and a normal oxygen tension.

Many investigators have compared the effects of various positions on pulmonary function, and the general opinion is that Trendelenburg position is deleterious, unphysiologic and harmful, and that the supine or horizontal on-the-back position is not as advantageous to the patient as is the head-up, feet-down position so far as pulmonary function is concerned.

Christie and Beams [4] reported a decrease in vital capacity when the patient was changed from the sitting to the supine or horizontal position. Wilson [5] noted that there is a decrease in reserve air when a patient is changed from the erect to the horizontal or recumbent position. Livingstone [6] proved by roentgenographic studies that in normal subjects the capacity of the chest is least when the subject is supine or horizontal and greatest when he is erect. Hurtado and Fray [7] showed by roentgenograms that the level of the diaphragm is higher and the lung field area smaller when a patient lies flat on his back than when he is in the sitting or reverse Trendelenburg position. McMichael and McGibbon [8] pointed out that the increased amount of blood in the thorax in the recumbent position is a factor in decreasing lung volume. Altschule and Zamcheck [9] found that the functional residual air, reserve air and vital capacity were lowest in Trendelenburg position. Case and Stiles [10] found the Trendelenburg position unfavorable so far as vital capacity was concerned. Slocum et al. [11] opined that any factors which cause elevation

* The term reverse Trendelenburg position is synonymous with Fowler's position, head-up position and feet-down position. All of these terms may be used interchangeably in this paper. Synonymous also are the terms supine position, horizontal position and dorsal recumbent position.

of the diaphragm and increased abdominal pressure predispose to the development of atelectasis during or following surgery. Drinker et al. [*12*] reported that abnormal amounts of blood in the pulmonary circuit, as occurs with Trendelenburg position, interferes with entrance of air into the lungs. Sokalchuk et al. [*13*] proved that the highest vital capacity was obtained with the patient in the sitting position, and that the reverse Trendelenburg position was favorable from the standpoint of pulmonary function.

Mayerson [*3*] proved in experiments on dogs that the tilting of anesthetized dogs from the horizontal to the upright, feet-down position is accompanied usually by a sharp drop in intrafemoral and intracarotid blood pressure followed within 10 seconds by a compensatory rise of varying degree. While there is seldom complete compensation for the effects of gravity (due to the feet-down position) in dogs, there is usually an amount adequate to prevent serious cardiovascular embarrassment even when the animal is maintained in the feet-down position for several hours. Mayerson further reported that repeated tilting does not seem to fatigue the compensating mechanisms except in those instances when the anesthesia is very deep or the condition of the animal is very poor as judged by a low initial pressure and poor compensation on the first tilt. He showed experimentally that denervation of the carotid sinuses or cutting the vagi, thus eliminating the two aortic nerves, uniformly diminishes the animal's ability to compensate for gravity. The secondary rise in pressure in the feet-down period, as well as the rise after the return to the horizontal position, are smaller. In some cases compensation fails in the feet-down position. Elimination of both pressor receptor mechanisms usually results in complete absence of compensation and in many cases a drop in pressure to shock levels from which recovery is slight.

According to Simister and Conklin [*14*], this is not true in the rabbit. The rabbit can compensate even when the vagi, aortic, splanchnic and carotid sinus nerves were cut. Cutting these nerves in the human being has, according to our investigation, never been tested.

Gordh [*20*], in 1945, demonstrated that *deep* ether or *deep* intravenous anesthesia, utilizing evipal,® pentothal® or narcotol, was always accompanied by a considerable fall in blood pressure. Under *deep* ether, evipal or pentothal, a rapid fall in blood pressure always occurred in patients in the head-up position; when they were placed in the head-down position, blood pressure immediately rose above the horizontal level. When the animal was lightly anesthetized in the first or second stage of anesthesia, or plane 1 of the third stage, a compensatory rise occurred in the head-up posture, indicating postural compensatory activity. In deep ether anesthesia this compensatory rise never occurred, the pressure remaining on a plateau level. Under deep barbiturate anesthesia (stage 3, plane 4 or stage 4), respiratory arrest occurred in the head-up posture and an anoxic rise of the blood pressure was always seen, indicating a less depressed vasomotor center than during ether anesthesia.

Gordh [*20*] proved experimentally in both animals and man that whenever blood pressure falls to shock levels (60 to 70 mm. Hg), and even earlier, the patient should be placed in a slight head-down position with the legs straightened or elevated. This measure combined with excess of oxygen in the inspired air, besides intravenous fluid and blood transfusion, seems to be the most efficient treatment for impending shock from surgery and anesthesia. He further proved that under deep ether or deep "barbiturate-only" anesthesia the reverse Trendelenburg position is potentially dangerous due to a toxic depression of the vasomotor centers.

3. The depressant effect of ether or cyclopropane in a closed system and/or the excessive use of muscle relaxants or "barbiturate-only" anesthesia tends to augment further this depressed pattern of respiratory-circulatory dynamics.

4. The retention of carbon dioxide and its subsequent respiratory acidosis, altered pH and induced hypertension due directly to this position, plus the anesthesia drugs themselves, are obviously not functioning in the interests of homeostasis.

5. At the conclusion of surgery the following events occur: anesthesia ceases; the artificially high oxygen tension which accompanies most general anesthesias no longer exists; carbon dioxide which could not help but accumulate to some degree is suddenly no longer present. Since carbon dioxide exerts a constricting effect on blood vessels, its sudden elimination, with removal of the anesthesia mask, permits blood

vessels to dilate and lose their artificial constriction, with a consequent fall in blood pressure. (Although carbon dioxide may cause dilatation of the arterioles by local action, it also causes arteriolar constriction by its action on the chemoreceptors—a reflex—or by its central action.) Trendelenburg position ceases and the factor of gravity is abolished; the trauma of surgery is, of course, present plus the postoperative muscle weakness engendered by ether, pentothal overdosage or excessive use of muscle relaxants.

Adding up all of these factors, plus many more of which we are not yet aware (the rabbit's compensatory mechanism is still a mystery), one can begin to comprehend the phenomena involved in the immediate fall in blood pressure which frequently occurs after removal of the anesthesia mask and following prolonged surgery with the patient in the Trendelenburg and/or lithotomy-Trendelenburg position.

PROPHYLAXIS

For several years we have been observing the effects of performing surgery under a specific type of light general anesthesia which does not utilize ether, and with the patient in the reverse Trendelenburg position, his feet firmly implanted against a padded footrest. This position may vary from 10 to 30 degrees. We have attempted to employ as steep a position as is compatible with the individual surgeon's temperament, but not exceeding 40 degrees. The maximum of 40 degrees was based on the work of Hamilton [*15*] in 1932. He reported that as conscious male subjects reached an angle of 50 degrees in the reverse Trendelenburg position, while being supported on a tilting table, circulatory embarrassment commonly became evident and pulmonary minute volume increased. Hellebrandt and Brogdon [*16*], in 1938, found the same angle, 50 degrees from the horizontal plane, to be the critical position at which circulatory embarrassment became evident in young women.

We have observed the following: (1) The use of the reverse Trendelenburg position during light, etherless, general anesthesia and surgery affords high assurance against postoperative hypotension and shock. (2) If blood pressure is maintained during the operation in this position, it will assure against the portent of severe hypotension and shock postoperatively when the patient is in the horizontal position in bed. (3) Patients undergoing operation in this position may be moved from the table to the litter without fear of a serious fall in blood pressure. (4) If blood pressure begins to fall during the operation while the patient is in the reverse Trendelenburg position, it indicates the need for supportive measures such as glucose, blood or expanders. If the systolic pressure falls below 90, we place the table in the horizontal or in the Trendelenburg position until the factors responsible for hypotension are corrected. (5) The need for increased circulatory volume may often be masked while the patient is in the Trendelenburg position.

There are several variations on this theme which are as follows:

1. In instances when surgery would normally be performed with the table horizontal, such as appendectomy, gastric resection, cholecystectomy, radical breast, thoracic and cardiac surgery, head and neck surgery including brain surgery, disk operations, orthopedic surgery, and surgery of the extremities, we have placed the table in reverse Trendelenburg position, and maintained it in this position from the beginning to the very end of the operation.

2. For gynecologic or pelvic surgery via the abdominal route, the Trendelenburg position facilitates the surgeon's art. We permit the use of this position only until the peritoneum is closed. The moment the peritoneum is closed, the operating team steps away from the table, the overhead surgical spot lights are readjusted, and the table is swung into a steep reverse Trendelenburg position and maintained thusly until the last skin suture is placed. Closure may require from ten to thirty minutes. This affords the patient time to adjust to this new position while still under the influence of anesthesia. When the anesthesia mask is removed at the termination of surgery, the table is leveled to the horizontal position so that if emergent vomiting occurs it can be managed minus the portent of aspiration.

3. For surgery involving the perineal approach (i.e., perineal prostatectomy, vaginal hysterectomy, etc.), the use of stirrups and the lithotomy position, when we are unable to employ the reverse Trendelenburg position (since the termination of surgery is usually simultaneous with the termination of anesthesia), we do two things: (a) Prior to removing the anesthesia mask and before taking the

patient's legs from the stirrups, we place the table in steep, reverse Trendelenburg position. (b) We then wrap each leg from ankle to inguinal region with an ace elastic bandage. The legs are placed flat on the table. It requires about five minutes to wrap the legs, and anesthesia is continued meanwhile until the completion of the wrapping. At this point the mask is removed and the table is leveled to the horizontal position simultaneously. Anesthesia is purposely continued to the last moment of wrapping the legs so that the patient will have as much time as possible to adjust to the steep reverse Trendelenburg position while still under the influence of the anesthetic gases. After the elastic bandages are applied, the mask is removed and the table leveled to the horizontal position. Our rationale for elastic bandages is that they tend to increase the relative blood volume by compressing the vascular bed, and at the same time augment venous return from the lower extremities. This, in effect, may be considered as an autotransfusion.

Fairley [*21*] attributes the hypotension and bradycardia seen after major vaginal surgery to what he terms a "pelvicardiac reflex." He attributes this reflex to impulses arising from the pelvic nerve endings on the afferent side and producing an increase in vagal tone on the efferent side. He treats hypotension by the intravenous administration of an anticholinergic drug such as atropine.

METHOD OF ANESTHESIA USED IN THIS STUDY

Anesthesia for this study of 2,500 cases consisted of a method which utilizes no ether whatsoever. Although described in full detail elsewhere [*17–19*], briefly, it consists of a mixture of 11.7 per cent cyclopropane, 29.4 per cent nitrous oxide and 58.9 per cent oxygen, administered via a semi-closed absorption system. To obtain these percentages the flowmeters are set at 400 cc of cyclopropane per minute, 1,000 cc. of nitrous oxide per minute and 2,000 cc. of oxygen per minute. Exhalations are partially exhausted into the operating room via an exhalation valve. For children and infants, these flows are doubled. This mixture of gases will not produce surgical anesthesia. However, if a small dose of some ultra short-acting barbiturate such as pentothal, evipal or neraval® (average dose is 8 cc. of a 5 per cent solution in an adult, less in children) is injected intravenously, this mixture of gases will maintain plane 1 surgical anesthesia for an indefinite number of hours without the need for additional, or intermittent doses, of the barbiturate. Since plane 1 will not produce adequate abdominal relaxation, muscle relaxants are utilized when indicated. The advantages in this method of anesthesia are: non-fluctuating, light, persistent, plane 1 anesthesia without the portent of overdosage; rapid postoperative recovery, usually within eight to ten minutes regardless of the duration of surgery; and less postoperative nausea and vomiting in comparison with other methods of general anesthesia.

This method of anesthesia has been employed for all types of surgery, and one study reported 25,000 human administrations without a fatality [*19*].

SUMMARY

The reverse Trendelenburg position is advocated as the optimum position for surgery while patients are under light, etherless, general anesthesia. The use of this position affords a high degree of protection against postoperative hypotension and shock. The pharmacophysiologic reasons for the use of this position are discussed, as well as the method of anesthesia employed.

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Clinical Observations with a New Non-barbiturate–Hypnotic Agent (Glutethimide) in Preoperative Sedation and in Certain Selected Patients

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SINCE the publications by Emil Fischer and Von Mehring concerning the pharmacologic somnifacient action of diethyl barbituric acid (veronal®) fifty years ago, numerous barbituric agents have been utilized to induce sleep and to prepare patients for surgery. Many attempts have been made to find a non-habit–forming sedative-hypnotic with sufficient effectiveness and no undesirable side effects.

It is extremely desirable to have available as a therapeutic adjunct a hypnotic-sedative that can be administered to certain selected patients, i.e., patients who are sensitive to barbiturates, elderly patients who cannot tolerate the undesirable effects of barbituric acid compounds, chronically ill persons, patients with a low vital capacity and poor respiratory reserve, and those with hepatic disease (cirrhosis, metastatic carcinoma) who have impaired liver function and are unable to metabolize barbiturates.

A new non-barbiturate, mild-acting, sedative-hypnotic, doriden,®* considered to be less habit-forming, non-toxic and free from undesirable side reactions, has been reported [*1–4*]. Pharmacologic studies have been published [*5*] showing that this drug, a glutaric acid imide, is an effective somnifacient and anticonvulsive [*6,7*] free of untoward hemopoietic alterations. Although the metabolism of doriden by the liver has not yet been determined, reports [*1,2*] have thus far revealed no hepatorenal dysfunction.

Chemically, doriden is an alpha-ethyl-alpha-phenyl-glutarimide and differs from paraldehyde, chloral hydrate and the bromides.

It was believed that a drug with the potentials attributed to doriden would be valuable in preoperative sedation and in certain specific cases. Thus a clinical study of the effect of this agent on seventy-five patients was undertaken. The purpose of this paper is to evaluate the physiologic effects of this drug and to determine its efficacy and practicability as applied in specific clinical cases.

ANALYSIS OF CASES

Seventy-five patients taken primarily from the proctologic division of the Surgical "A" Service of the Jefferson Medical College Hospital were utilized in this study.

The majority of the patients receiving doriden were prepared for proctologic surgical procedures, and several for sigmoidoscopy; others were convalescing from colonic surgery. Complete clinical histories and physical examinations with pertinent blood studies and urinalysis were performed in the group studies.

Doriden was administered as a sleep-inducing agent on the night prior to surgery and was given two hours before the surgical procedure in the majority of cases reviewed clinically.

The clinical features, type of anesthesia and preoperative medication were considered in each case. The dosage of the drug, route of administration, induction time, duration of

* The doriden used in this study was provided by the Research Department of Ciba Pharmaceutical Products Inc., Summit, New Jersey.

sleep, and cardiovascular, cardiorespiratory and other systemic manifestations produced by this sedative-hypnotic were incorporated into this survey.

Clinical Features. Of the total group studied, forty were females (53 per cent) and thirty-five were males (47 per cent). The age range varied from eighteen to seventy-six years, with an average of fifty-one years. (Table I.)

TABLE I
AGE GROUP OF PATIENTS

Age (yr.)	No. of Patients
10–20	1
20–30	2
30–40	7
40–50	20
50–60	26
60–70	16
70–80	3

TABLE II
SURGICAL PROCEDURES PERFORMED

Procedure	No. of Patients
Hemorrhoidectomy	39
Fistulectomy	14
Removal of polyps	6
Incision and drainage	7
Anal plastic procedure for stricture	1
Removal of fissures	3
Biopsy	1
Pilonidal cystectomy	1
Plastic revision of gracilis sling	1
Sigmoidoscopy	7
Alcohol injection, pruritus ani	1

The majority were in the age group of forty to sixty years, comprising 61.3 per cent of the total series.

Of the seventy-five patients studied, seventy-one were white (94.6 per cent) and four were Negroes (5.4 per cent).

Eighty-one surgical procedures were performed; hemorrhoidectomy was the operation most frequently performed. (Table II.)

Doriden was administered as a sedative on the night before surgery in the following instances: postoperative Miles' resection for carcinoma of the rectum, three patients; abdominal exploration for associated colonic lesions, two patients; resection of sigmoid and descending colon for recurrent carcinoma of colon, one patient; postoperative portacaval shunt for portal cirrhosis and varices, one patient.

The type of anesthesia most frequently administered was straight single-dose spinal, 75 mg. of 1 per cent procaine hydrochloride; this was used in forty-seven patients of the total series. (Table III.) Continuous spinal, general and pentothal anesthesia accounted for the other types. Ten patients received only analgesics, i.e., morphine or demerol with or without atropine sulfate for those procedures requiring no anesthetic. Eleven patients of the total group studied received no anesthetics or analgesics.

TABLE III
TYPES OF ANESTHETICS ADMINISTERED

Type of Anesthetic	No. of Patients
Straight spinal	47
Continuous spinal	1
Pentothal	4
General*	1
Analgesics†	10
No anesthesia	11

* Consisted of gas, oxygen and ether.
† Morphine or demerol with or without atropine.

Doriden was administered orally. The average dose was 1 gm., varying from a minimum of 0.25 gm. to a maximum of 1.5 gm. The time before sleep was produced ranged from fifteen minutes to 210 minutes, and averaged fifty-nine minutes. The duration of sleep produced by this hypnotic was found to vary from three hours to twelve hours, the average being approximately six hours.

Physiologic Effects. The effects of doriden on cardiovascular and cardiorespiratory function were observed in seventy-five cases. Respiratory function was not significantly altered, but a decrease in the pulse rate and blood pressure was noted. The decrease in systolic and diastolic blood pressure ranged from 2 to 40 mm. Hg, and the average decrease was 18 mm. Hg as observed in 46.6 per cent of the cases studied.

In thirty-six patients there was a reduction in pulse rate by approximately ten beats per minute. This observation in cardiovascular

alteration is at variance with reports published by other investigators [1,2].

In seven patients the systolic blood pressure was elevated 10 mm. Hg or more, and the pulse rate was increased by ten beats per minute. Preoperative apprehension, preparation for surgery with enemas and other factors may account for these cardiovascular changes.

Side Effects. Dizziness in six patients (8 per cent) and nausea in four (5 per cent) were the predominant subjective complaints presented by the patients in this group. Other effects produced by doriden were as follows: complete sensorium oblivion, two patients (2.6 per cent); confusion and agitation, two patients (2.6 per cent); and headache, one patient (1.3 per cent). The blood pressure dropped to shock level during the operative procedure in three patients of the total group observed (4 per cent). However, the concomitant premedication with morphine and straight spinal anesthesia may have influenced this blood pressure alteration.

SUMMARY

1. Clinical observations with a new non-barbiturate, sedative-hypnotic agent for preoperative sedation in a study of seventy-five cases have been presented.

2. A critical determination of the efficacy and practical use of this drug was conducted by administering doriden for preoperative sedation on the night prior to surgery and two hours before surgery.

3. In the majority of patients, a dosage of 1,000 mg. taken orally induced effective hypnosis in approximately one hour, and the duration of sleep averaged six hours.

4. The respiratory rate was not affected, but the pulse rate and blood pressure were significantly diminished.

5. Few significant untoward side effects were noted during surgery except for the lowering of blood pressure in three patients. Dizziness and nausea were the two most common subjective complaints elicited, but in the majority of cases the patients' sensorium was clear and there was cooperation with a good sense of well-being and no hangover.

CONCLUSIONS

1. Doriden, a non-barbiturate hypnotic-sedative has been given a clinical trial. The drug was found to be relatively non-toxic and produced few undesirable side effects. It is an effective somnifacient with a therapeutic effect midway between seconal® and nembutal.®

2. It is considered to be a beneficial therapeutic adjunct in the preoperative sedation of patients undergoing proctologic or general surgery.

3. We believe this new hypnotic-sedative deserves further clinical study because of the potential advantages of its use in patients addicted to or sensitive to barbiturates, in the elderly and chronically ill, in those with low vital capacity and poor respiratory reserve, and in those with hepatic disease who are unable to metabolize barbiturates.

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A New Local Anesthetic

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PROCAINE, which is perhaps the most widely employed of all local anesthetics, has been in use for over fifty years. Like ethyl ether in the field of general anesthesia, procaine as a local anesthetic not only has maintained its leadership in the field but also, despite the introduction of large numbers of competitive compounds, still remains the standard against which all other local anesthetics are measured. However, notwithstanding its many good points and its wide use, procaine has certain limiting characteristics which impose restrictions upon its broader employment and utility. For instance, the anesthesia produced is slow in taking effect and is relatively short in duration, particularly so without added vasoconstrictors. Being a relatively weak anesthetic, often large volumes of solution are required for nerve block injection. It is practically inactive as a topical anesthetic and its use is contraindicated during or prior to sulfonamide therapy.

It is these limitations which other newer local anesthetics seek to overcome in attempting to achieve improved anesthetic activity. Many of the individual drawbacks associated with procaine have been adequately overcome by one or another of the newer local anesthetics. However, in the opinion of the authors, blockain,®* brand of propoxycaine hydrochloride, a local anesthetic recently introduced for infiltration and nerve block anesthesia, comes closer to obviating all the limitations of procaine than any other local anesthetic, and stands out as providing the medical profession with an almost ideal local anesthetic for general use.

Some groups of cases in which this new local anesthetic has been used are herein presented, together with a review of some of the pharmacologic data in support of the clinical findings.

Chemically, propoxycaine hydrochloride is diethylaminoethyl-2-propoxy-4-aminobenzoate. It is one of a series of thirty-eight compounds studied by Luduena and Hoppe [*1*] for their local anesthetic activity, acute toxicity and local tissue irritant properties. Propoxycaine HCl was the most promising of a subseries of 2-alkoxy procaine derivatives. This particular series, with increase in length of side chain, revealed a progressive increase in anesthetic activity, but not in tissue irritancy.

Luduena [*2*] has carried out a comparative pharmacologic study of propoxycaine HCl and procaine, and has found that only one-tenth the concentration of propoxycaine HCl is needed to produce the same degree of nerve block when assayed by the guinea pig sciatic nerve test. In terms of potency, propoxycaine HCl therefore has ten times the activity of procaine; yet local irritation, a property common to all local anesthetics, has been demonstrated by the trypan blue method to be only 1.9 times that of procaine. This gives an activity:irritation ratio of approximately 5:1 in favor of propoxycaine HCl. Clinically this means that propoxycaine HCl would be better tolerated at the site of injection than procaine when used in concentrations which produce the same anesthetic effect. To put it somewhat differently, a solution of propoxycaine HCl would have approximately five times the anesthetic strength of a solution of procaine producing the same degree of irritation. It has also been shown by Luduena that propoxycaine HCl is relatively much less irritating than procaine when injected intraspinally in rabbits. No permanent paralysis has been seen at any dose following the injection of propoxycaine HCl, even with doses which paralyzed respiration, whereas permanent motor paralysis

* Registered trademark of George A. Breon & Co., New York, N. Y.

can be produced by procaine injected intraspinally at less than lethal doses.

As mentioned heretofore, nerve block anesthesia assayed by the guinea pig sciatic nerve method indicates that propoxycaine HCl is approximately ten times as potent as procaine. The intradermal wheal method in guinea pigs also indicates a potency ratio of the same order. Acute intravenous toxicity tests in mice indicate a ratio of approximately 8:1, that is, propoxycaine HCl may have a slight advantage over procaine in terms of activity:toxicity ratios. The fact that only this slight difference can be demonstrated seems to agree with the correlation studies of Luduena, Hoppe and Borland [3], in which it was shown by a study of sixty-one compounds that a highly significant positive correlation existed between local anesthetic action as determined by the intracutaneous wheal method and the intravenous toxicity in mice. A similar positive correlation was found when the activity of twenty-five compounds determined by intraspinal injection in rabbits was compared with their intravenous toxicity. For practical considerations the greater degree of activity demonstrated by propoxycaine HCl means that operative procedures previously ruled out by the large volumes of procaine solution required or the inadequacy of the anesthesia produced by procaine are now not only feasible but also quite practical.

The duration of anesthesia is often of critical importance in determining the particular compound to be used. Propoxycaine HCl, when assayed on the cat's sciatic nerve *in vivo* and compared with equianesthetic doses of procaine, had a duration recovery time of 50 to 100 per cent longer. This marked increase in length of action may be due in part to the vasoconstriction which has been observed when propoxycaine HCl is injected into the femoral artery of the barbitalized dog. Procaine under identical conditions acts as a vasodilator.

As a topical anesthetic it has been demonstrated that propoxycaine HCl is far superior to procaine. When assayed by the corneal anesthesia method in rabbits, propoxycaine HCl was found to be approximately thirty times as potent as procaine and approximately twice as potent as cocaine.

One of the drawbacks to the use of procaine has been its ability to antagonize the action of the sulfonamides. This is usually a minor consideration, yet it is quite important when a local anesthetic is to be injected in an infected or abscessed area under treatment with sulfonamide. Procaine when hydrolyzed by tissue pseudocholinesterase liberates p-aminobenzoic acid, a direct sulfonamide antagonist. Propoxycaine HCl, on the other hand, does not form p-aminobenzoic acid on enzymatic hydrolysis and hence cannot be expected to inhibit sulfonamide activity. Actually, propoxycaine HCl itself possesses a significant bactericidal activity of its own against Staphylococcus aureus and Pseudomonas aeruginosa, as has been demonstrated by Klimek [4].

MATERIALS AND PROCEDURE

Over a period of nine months propoxycaine HCl was used as the local anesthetic in seventy-one surgical procedures. The patients were from a large industrial practice, and consequently most of the procedures involved the repair of crushing injuries, lacerations and amputations.

The patients ranged in age from nineteen to sixty-five years, with the average age of 35.5. Because of the type of practice involved, all but one of the patients were male. A 0.5 per cent solution of propoxycaine HCl was employed in these cases, and the volume used per patient varied from 1 to 17 cc., with an average of 3.3 cc. Thirty-six lacerations were repaired under infiltration anesthesia and three under digital block anesthesia. All these lacerations were small, being 3 inches or less in length, with the exception of four cases, in which the length was 4, 5, 8 and 9 inches, respectively The amount of propoxycaine HCl infiltrated in each case varied from 0.75 to 8.0 cc., with an average of 2.25 cc. per case. The three digital blocks were accomplished with 0.75, 1.0 and 1.5 cc. The duration of surgery varied from six minutes to ninety minutes, with an average duration of twenty-four minutes.

Of the seventy-one patients treated, eleven were judged to have pain sufficient to require analgesia prior to surgery. These patients were treated with 50 to 100 mg. demerol.® However, in all cases the initial amount of anesthetic proved sufficient to maintain anesthesia throughout the entire procedure; moreover, it was observed that in every case the onset of anesthesia was instantaneous and there was

no need to delay the start of the surgical repair because of delayed anesthetic effect.

Ten patients suffered injuries which required amputation of part or all of one or more digits. Three operations were performed under infiltration anesthesia with an average amount of propoxycaine HCl of 3 cc. per amputation. In one case the distal halves of two terminal finger phalanges were removed using only 2 cc. per finger. In the other seven amputations, block alone was employed, with the exception of one case in which a combination of block and infiltration was necessary because of the extent of the surgery; the terminal phalanx of the left index finger was amputated using 4 cc. and there was extensive surgical repair of the left middle and ring fingers, where 2 cc. per finger were employed. In the other six cases, in which block alone was used, ten digits were amputated in whole or in part. The amount of anesthetic employed in these block procedures varied from 1 to 4 cc. per digit, with an average of 1.9 cc.

TABLE 1

Procedure	No. of Cases	Dose of Propoxycaine HCl
Skin graft of thumb	1	3 cc. thumb, 2 cc. abdomen
Repair of puncture wound, ethmoid sinus	1	2 cc.
Removal of splinter	2	1 cc. each case
Removal of a tumor of the breast	1	5 cc.
Inguinal hernia	2	13 and 17 cc.
Vasectomy	1	1 cc. each side
Tonsillectomy	2	3 and 4 cc. each side

A group of twelve patients had severe crushing injuries to the hand and/or fingers requiring extensive surgical reconstruction and repair. The amount of anesthetic used in these cases varied from 1.5 to 12.0 cc., with an average amount per case of slightly more than 3.0 cc. In three of the cases there were additional crushing injuries to other parts of the body. One was a severe crushing injury to the foot in which all the metatarsals were fractured, all the tendons on the dorsum of the foot were torn and the fractures were compound. This patient, requiring extensive surgical repair, was adequately anesthetized with a total of 8.0 cc. of propoxycaine HCl. In the second case there was a crushing injury to the left great toe; 1.5 cc. of propoxycaine HCl for the nerve block was adequate. The last patient had a compound comminuted fracture of the nose. Under 3.0 cc. of propoxycaine HCl infiltration anesthesia the wound was enlarged, the bone fragments were elevated and sutured in place, and the external wound was closed.

Ten additional miscellaneous surgical procedures were performed. These are summarized in Table 1.

COMMENTS

The cases cited herein illustrate several points which make propoxycaine HCl a useful new local anesthetic. The onset of anesthesia with propoxycaine HCl is very rapid. It is unnecessary for the operator to wait for anesthesia to develop after injecting the anesthetic. Propoxycaine HCl is effective in very small amounts (average of all cases, 3.3 cc.). Duration of anesthesia is longer than that obtained with procaine, even with the addition of a vasoconstrictor. In none of the cases so far seen did propoxycaine HCl fail to produce adequate anesthesia for a period of time sufficient to complete the operative procedure. No side effects were observed in any case.

SUMMARY

1. An outline of the pharmacology of propoxycaine HCl, a new local anesthetic, is presented.

2. Seventy-one cases in which propoxycaine HCl was used as a local anesthetic are reviewed.

3. Salient features of the satisfactory performance of propoxycaine HCl include: (a) rapid onset, (b) effective in small dosage, (c) prolonged anesthesia, (d) absence of side effects.

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Urinary Retention in Anorectal and Colonic Surgery

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THE problem of urinary retention following surgery on the anus, rectum and colon is one of the most common that the proctologist must face. Much has been written on this subject in regard to Miles' abdominoperineal resection [4,7] and proctosigmoidectomy with preservation of sphincters [1,2]. However, there is a scarcity of literature on the incidence of urinary retention subsequent to anorectal surgery, and many do not consider it to be a problem. We disagreed with this point of view, and hence conducted a statistical survey to determine the actual incidence and whether or not it could be reduced. All cases studied were taken from the proctologic service of the Allentown Hospital. The study was divided into two parts. The first covered a period of nine months from November, 1953 to July, 1954. During this interval the past records of 200 consecutive cases of anorectal surgery were taken from one service, and the degree of urinary retention determined. In this group the incidence was 48.5 per cent. Table I gives a breakdown as to anesthesia; the sex distribution is shown in Table II.

TABLE I
TYPE OF ANESTHESIA USED

Anesthesia Used	No. of Cases	Catheterized (%)
Local	19	31
General	5	40
Spinal	176	50.5
Totals	200	48.5

TABLE II
SEX DISTRIBUTION OF FIRST GROUP: 200 CASES

Sex	No. of Cases	Catheterized (%)
Male	112	43.8
Female	88	54.4

As can be seen from Table I, this is a higher figure than one might suspect. A careful analysis of the charts was carried out to determine the reason for this excessive rate of catheterization. It was found that in thirty-two (16 per cent) of these patients, 300 cc. or less of urine was obtained. The desire to void occurs at 250 to 300 cc. and the bladder capacity is 400 to 450 cc. [6]. We believed that in this group of patients the catheter was used before patients were given ample opportunity to void. The routine order on the chart was "catheterize p. r. n." which left this procedure to the discretion of the nurses. Thus, in many cases, it was carried out in six to eight hours. This was further amplified by the fact that 54.4 per cent of the female patients were catheterized as compared to 43.8 per cent of the male patients. One would expect the reverse to be true, but the female patients were attended by nurses and were generally catheterized earlier and more frequently than were the male patients who required the services of an interne.

The second group in this study consisted of 550 cases of anorectal surgery covering a period of twelve months from January to December, 1955, and 100 of abdominal surgery cases extending through an interval of two years from January, 1954 to January, 1956. Routine orders were left on all cases of anorectal surgery that the patient was to be gotten

out of bed to void in fourteen hours. If unsuccessful, this was to be repeated in four hours. Patients were not to be catheterized under eighteen hours unless distention was present. In a study on postoperative urinary retention by Treiger et al. [8], 2,000 cases were reviewed

TABLE III
SEX DISTRIBUTION OF SECOND GROUP: 550 CASES

Sex	No. of Cases	Per cent Catheterized
Male	293	21.1 (62)
Female	257	17.4 (46)
Totals	550	20.2

TABLE IV
AGE DISTRIBUTION OF MALES

Age	No. of Cases	No. Catheterized	Per cent
10–19	10	1	10
20–29	33	5	15
30–39	75	18	24
40–49	84	14	16
50–59	59	15	25
60–69	27	8	29
70–79	5	1	20
Totals	293	62	21.1

TABLE V
AGE DISTRIBUTION OF FEMALES

Age	No. of Cases	No. Catheterized	Per cent
10–19	2	..	0
20–29	43	12	27
30–39	70	18	25
40–49	78	8	10
50–59	41	6	14
60–69	20	2	10
70–79	1	0	0
80–89	2	0	0
Totals	257	46	17.4

and it was found that the kidney excretion rate was reduced to 23.5 cc. per hour, with the average patient voiding 330 cc. in fourteen hours. Assuming that the patient voids prior to surgery and does not receive intravenous fluids, as seldom occurs in cases of anorectal surgery, eighteen hours should transpire postoperatively for the average patient before the bladder capacity is reached and it is necessary to resort to catheterization. It was a common observation that the urge to void occurred very early postoperatively in patients who had undergone anorectal surgery. This is probably

TABLE VI
TYPE OF ANESTHETIC USED

Anesthetic Used	No. of Cases	Per cent Catheterized
Local	404	16.5 (67)
Spinal	125	30.4 (38)
General	21	14.3 (3)

TABLE VII
NUMBER OF CATHETERIZATIONS REQUIRED

	No. of Cases	Per cent
Catheterized once	78	72
Catheterized twice or more	30	28
Foley catheter inserted	19	17

TABLE VIII
USE OF RECTAL PACKS POSTOPERATIVELY

Type Used	No. of Cases	Per cent Catheterized
Gelfoam®, Oxycel®	326	17.4 (63)
No pack	42	9.5 (4)

due to bladder spasm secondary to pain as the parasympathetic, sympathetic and cerebrospinal systems innervating the rectum and anus and the bladder and urethra are identical. In addition, there is a close anatomic association between the rectum and the urethra via the rectourethralis muscle. According to Gorsch [3], "The intimate connection of the anorectum with the urogenital sphincters by this muscle is very significant to postoperative urinary retention [3]. Thus, patients complained of urgency and yet were unable to void, with the result that many patients were catheterized earlier than was necessary. Patients were told to disregard this false desire to void. They were also encouraged to drink beer if they were in the habit of doing so. All measures were used to get the patient to void, short of catheterization.

Prostigmin® appears to be of no value, as shown by McLaughlin and Brown [5], and hence was not used.

Analysis of the 550 cases of anorectal surgery showed a urinary retention rate of 20.2 per cent. (Table III.) This was minus fourteen patients with pilonidal cysts who voided spontaneously. Thus, 108 of the 534 anorectal cases required catheterization. These cases were then analyzed as to sex, age, anesthesia, number of catheterizations, use of rectal packs and lastly, the injection of long-acting anesthetics. (Tables IV to IX.)

TABLE IX
INJECTION OF LONG-ACTING ANESTHETICS

Type Administered	No. of Cases	Per cent Catheterized
Eucupin®	56	35 (20)
Efocaine	..	.....
No anesthetic given	69	26 (18)

TABLE XII
OPERATIVE PROCEDURES ON THE COLON

Operation	No. of Cases
Miles' resection	18
Pull-through with preservation of sphincter	6
Left colon resection	26
Posterior resection	3
Other procedures, i.e., colostomies, polypectomies, etc	47

In addition to the information given in the tables, it was found that the average amount of urine obtained was 556 cc., with the average patient being catheterized at 17.7 hours. Thus, the average kidney excretion rate was 27.7 cc. per hour in the 108 patients who had been catheterized. The average stay in the hospital for those patients with urinary retention was seven days as compared to 5.7 days for those who voided spontaneously. The incidence of urinary infection in the 108 catheterized patients was 7.4 per cent.

From these statistics it is seen that the incidence of urinary retention was reduced from 48.5 to 20.2 per cent. The rate of catheterization is lowest in females; when a local anesthetic is used; and when a rectal pack is not used.

Analysis of the 100 cases of abdominal surgery is shown in Table X. These were then broken down into their respective incidences and infection. (Table XI.) The high figures of infection in the Miles abdominoperineal resection are comparable to an analysis of 500 cases with similar operations by Jones [4], in which he reported an incidence of 95 per cent urinary infection. Nothing new is suggested with regard to urinary retention in colonic surgery. The problem here is entirely different from that of anorectal surgery and the series studied is too small to arrive at any conclusion.

TABLE XI
URINARY RETENTION AND INFECTION IN 100 CASES OF COLONIC SURGERY

Procedure Performed	No. of Cases	Retention (%)	Infection* (%)	Catheterized (%)	Foley Catheter Inserted (No. Cases)
Miles' resection	18	28	55	....	18
Pull-through	6	0	0	....	6
Posterior resection	3	33	66	33	1
Left colon resection	26	3.8	8.2	7.6	22
Others	47	....	6.3	25.5	26

* Urinary infection occurred in 16 per cent (males, 12 per cent; females, 4 per cent).

CONCLUSIONS

1. Seven hundred fifty cases of anorectal surgery were studied for urinary retention. In the first group of 200 cases used as a control the incidence was 48.5 per cent. In the second group of 550 cases the incidence was reduced to 20.2 per cent.

2. Postoperative catheterization in cases of anorectal surgery can be reduced by delaying catheterization until the bladder is actually full, that is, fourteen to eighteen hours.

3. The complication of urinary retention in anorectal surgery appears to be lowest with the use of local anesthesia.

4. Withholding the insertion of a rectal pack

further reduces the incidence of urinary retention.

5. One hundred cases of abdominal surgery were reviewed. The incidence of urinary retention and infection was found to vary with the type of procedure performed, the greatest being with Miles' abdominoperineal resections.

6. In surgery of the anus, rectum and colon, urinary retention is the most common postoperative complication encountered.

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Often a disease of younger adults, chronic, intractable ulcerative colitis, can be best treated by permanent ileostomy plus colectomy. Both operations may be performed at the same time if the patient's condition permits, or the colectomy can be performed later. However, until performed, the patient's symptoms will not improve appreciably. (*Richard A. Leonardo, M.D.*)

An Improved Colostomy Irrigating Tube

REPORT OF A CASE OF PERFORATION OF COLOSTOMY LOOP

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INSTANCES of accidental perforation of colostomy loops occurring with irrigation have occasionally been reported. Moreover, difficulties in colostomy management, particularly as regards easy and effective irrigations, are commonly encountered. The problem confronting the patient with a colostomy is to obtain an efficient irrigation with water injected under moderate pressure, yet without allowing regurgitation through the stoma. Patients may do it in several ways: (1) by using complex attachments of plastic or rubber, (2) by inserting a tube into the colostomy at an excessive distance (10 to 12 inches), or (3) by using manual pressure over the stoma. Most patients come to rely on one or both of the latter two methods, thus exposing themselves to the danger of accidental perforation.

The following case report of perforation of the colon during a self-administered colostomy irrigation illustrates the ease with which this catastrophe may occur.

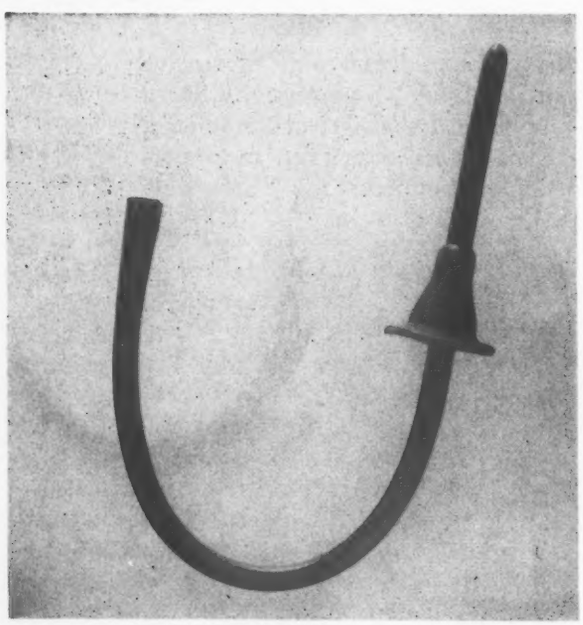

FIG. 1.

CASE REPORT

C. B. (Hahnemann Hospital, No. 55323), a seventy-two year old, single, white female schoolteacher, had undergone abdominoperineal resection for carcinoma of the rectum on May 8, 1951, with an uneventful recovery. She had gained weight and was doing well until a few weeks prior to admission when she began to have difficulty inserting the irrigating tube into the colostomy to the accustomed length (about 10 inches). She was a fastidious woman who insisted on vigorous and thorough irrigations. She believed that the irrigation was satisfactory only if the tube was inserted the entire length. Following the insertion of the tube on the morning of her admission (January 22, 1952), the patient experienced a sudden onset of pain in the left lower quadrant. She vomited once shortly thereafter.

An Improved Colostomy Irrigating Tube

Examination revealed redness around the colostomy and adjacent skin. The abdomen was tender on the left side and to a lesser degree on the right side. There was rebound tenderness over most of the abdomen; peristalsis was absent.

At operation she was found to have a perforation 6 inches from the stoma. The left upper quadrant collection was evacuated of fecal material and enema water, and drained. Transverse colostomy was performed, excluding the perforated loop. The patient was discharged on February 16th. Three months later the transverse colostomy was closed, and she made an uneventful recovery.

For a number of years we have used a shield device* which allows the patient to irrigate his colostomy with a predetermined length of tube (3 to 4 inches). (Fig. 1.) This shield does two things: it prevents regurgitation of the irrigating fluid and permits a continuous and effective injection of fluid under moderate pressure. Our patients have found this irrigating tube safe, effective and inexpensive. Its use is readily understood by people of limited intelligence or those with a language difficulty. We recommend this tube for colostomy irrigations.

* Supplied by Davol Rubber Company, Providence, Rhode Island.

We recommend:

The Recurrent Laryngeal Nerves in Thyroid Surgery. By William H. Rustad, M.D. (Clinical Instructor in Surgery, University of California School of Medicine, San Francisco, Calif.). 47 pages, many illustrations and a bibliography. Springfield, Ill., 1957. Charles C Thomas. *Price* $4.50.

Etiologic Factors in Renal Lithiasis. Compiled and edited by Arthur J. Butt, B.S., M.D., F.A.C.S. 401 pages, illustrated, references at chapter endings. Springfield, Ill., 1956. Charles C Thomas. *Price* $12.50.

Operative Surgery. Under the General Editorship of Charles Rob, M.C., M.CHIR., F.R.C.S. (Professor of Surgery, St. Mary's Hospital, London) and Rodney Smith, M.S., F.R.C.S. (Surgeon, St. George's Hospital, London). Twenty-three contributors. Volume 1, Introductory Surgery of Trauma to the Abdomen. 342 pages, illustrated. Philadelphia, 1956. F. A. Davis Co.

A Simple Collection Arrangement for T-Tube Drainage

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FOR the past five years we have been using an ordinary rubber glove as a collecting bag for bile which drains from a T-tube. (Fig. 1.) The glove overcomes some of the disadvantages of other containers.

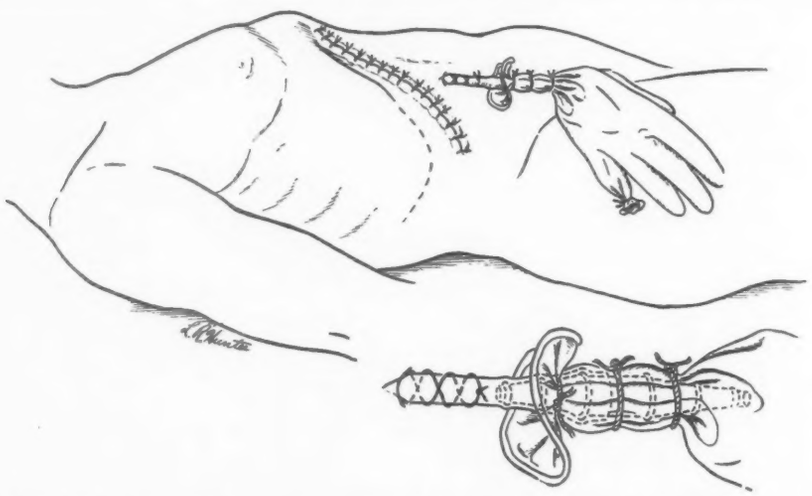

FIG. 1. The T-tube projects through a small opening in the abdominal wall a short distance from the subcostal incision. A silk stitch through the skin edges is "woven" around the T-tube and tied. The ties holding the glove fall in the ridges of the glass connector for secure fastening which is airtight and watertight.

Early ambulation and the danger of dislodging a T-tube by traction have caused many surgeons to abandon the use of a bedside bottle with connecting tube for collecting bile. The T-tube has been placed in a variety of containers which can be held in place on the abdomen or at waist level by the dressings, a binder or a suitable belt. Some of these receptacles have rigid walls so that they may require some provision for the escape of air as they fill with bile. Special containers are also an additional expense to the hospital and eventually to the patient when they are used.

In the method we propose, the T-tube is fastened by a stitch of silk through the skin and tied around the tube. Traction on the tube will cause pain and serve as an alarm should there be a threat of dislodging the tube. One end of a glass connector is inserted into the T-tube. The other end is inserted into the folded cuff of a collapsed rubber glove and tied in place. After the dressings are applied, the T-tube is fastened securely to the dressings by adhesive tape.

Complete sterility of the collecting apparatus can be maintained when it is attached in this manner. No opening is required for the escape of air. As the glove fills, it can be emptied by wiping a finger tip with germicide and simply cutting off the tip with sterile scissors. It can be completely emptied by compressing the remainder of it. After the glove is emptied, the open finger is ligated. Obviously the glove can be emptied repeatedly without contamination as each of the five projections can be cut off and ligated several times. Leakage has been the most serious disadvantage we have found in using the glove. The glove may burst if a patient rolls on it while it is distended, or it may leak if the ligature is insecurely tied after emptying. We recommend the use of a rubber glove for collection of T-tube drainage as a simple, safe and economical procedure.

A Method for Arterial Suture

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NEED for more rapid methods of arterial anastomosis has fostered various modifications in suture technic. Carrel [1] in 1902 with three traction sutures, and Frouin [4] in 1906 with four traction sutures, described methods of arterial anastomosis using the over and over continuous type of suture. Dorrance [3] in 1906 described an everting continuous suture; Gross and Hufnagel [6] in 1945, in their work with coarctation of the aorta, found the continuous everting suture technic to be the most satisfactory. Subsequently, the interrupted everting mattress technic has frequently been described for use on small or growing vessels. Shumacker and Lowenberg [8] in 1948 compare the results of these technics. DeBakey and Cooley [2] in 1953, and subsequent to that time, used a method whereby two sutures are anchored posteriorly. Each suture is brought anterior to the right and left of the vessel by through and through suture. They are then tied anterior to the vessel. Recently, in 1955, Goetz [5] described a "continuous interrupted everting suture." Also in 1955, Jennings and Cowley [7] used an everting suture with a two-pointed needle.

We wish to illustrate herein a method which can be used to speed the anastomosis of all sized arteries, but which is most useful when vessels are of equal size and in the range of 1 cm. It is especially useful when help is not available to hold the vessel ends in approximation at the time that suturing of the vessel ends is initiated. An application of the method can be made to both end-to-end and end-to-side anastomosis.

Two spring wires or adjustable loops formed from piano wire are made, 2 inches long and in a horseshoe shape. (Fig. 1*a*.) These are placed inside the ends of the arteries, or artery, and graft to be anastomosed. They act as a support and firmly hold the ends of the arteries so that they can be easily approximated, and yet the

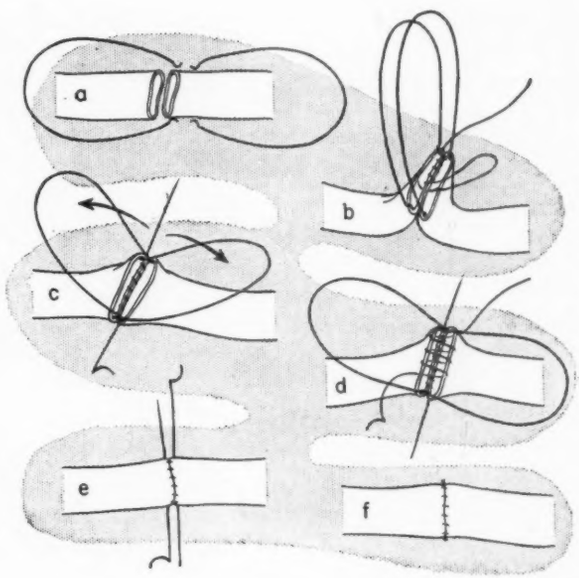

FIG. 1.

anterior wall is held apart from the posterior wall, making the identification of the wall easy for suture placement. (Fig. 1*b*.) The posterior wall of the artery may then be approximated by a continuous over and over suture. When the posterior row of sutures has been placed, one wire loop is passed through the other (Fig. 1*c*); thus, both wire loops come to lie flat against the artery with approximation of the anterior walls. A second continuous over and over suture, as shown in Figure 1*d*, is started in the opposite direction to the first so that the second needle will be at the opposite side of the artery when the anterior suture line has been completed. The wire loops are then removed and the anterior and posterior sutures are tightened. (Fig. 1*e*.) Frequently a single additional suture

is necessary at each end; this may be accomplished by the needle still attached at opposite ends of the artery. The sutures are now tied. (Fig. 1*f*.)

The diagrams illustrate the faster, continuous over and over technic. However, the continuous or interrupted everting mattress type technic may also be facilitated by the use of these wire loops.

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Safe Cholecystectomy

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CHOLECYSTECTOMY is one of the most common operations now performed by general surgeons, since most authorities agree that it is indicated whenever gallstones are present. The operation may be very easy or very difficult; it may be followed by a smooth recovery and excellent results, or there may be a stormy convalescence and poor results depending on the nature of the complications present preoperatively or which develop after the operation.

The most serious postoperative complications result from injury to the common or hepatic ducts which occurs during exposure of the cystic duct and artery preparatory to removal of the gallbladder from the cystic duct to the fundus. Its alarming frequence and serious sequelae were recently summarized by Moncrief [1]. Another complication is incisional hernia which results from the long incision necessary for exposure of the cystic artery and duct. Postoperative ileus and adhesions in the upper abdomen also may result from trauma caused by abdominal packs and vigorous retraction during surgery.

The aforementioned complications can be avoided by removal of the gallbladder from the fundus to the cystic duct, as described by Whipple [2]. Glenn [3] also recommends a similar technic saying, "In no instance have I talked with a surgeon who has injured the common duct while removing the gall bladder by dissecting it from the fundus toward the cystic duct." Schein and Hurwitt [4] recently described and recommended their technic of removal of the gallbladder from the fundus to the cystic duct.

The operation I performed usually required an 8 or 10 cm. vertical upper right rectus incision, without atrophy of the mesial portion of the rectus muscle, without postoperative herniation and, most important, without injury to the common or hepatic ducts.

Abdominal exploration and, if indicated and feasible, appendectomy are first performed. The fundus of the gallbladder is then grasped with one or two curved hemostats and lifted upward, and a bent ribbon retractor is placed beneath it. Additional retraction is obtained with the left hand of the assistant, with his fingers spread apart. No abdominal packs are used, as they traumatize the peritoneum. A circular incision is made through the serosa around the fundus of the gallbladder, just below the traction clamps, and the serosa is dissected from the muscularis from the fundus to the cystic duct, clamping and ligating branches of the cystic artery as soon as they are cut. The cystic artery itself is not seen, as it remains in the peritoneum reflected from the gallbladder. The gallbladder is also simultaneously dissected from the liver with care, finding a cleavage plane near the muscularis, and leaving the bed covered with fibrous tissue. The dissection is continued until the gallbladder is free, except for the cystic duct which is then exposed by blunt dissection. Blood or bile which escapes during dissection is immediately aspirated with a suction tip.

If small stones are present in the cystic duct, they are gently "milked" back into the gallbladder, and without clamping the cystic duct two No. 0 chromic catgut ligatures are tied around its proximal portion. A clamp is then applied to the mid-portion of the duct; it is cut across proximal to the clamp and the gallbladder is removed. Its bed is then carefully inspected for bleeding, which is controlled if present, and the serosa is sutured back in place with a running or purse-string suture of No. 00 chromic catgut on a curved intestinal needle, which leaves no denuded area. The steps in the operation are illustrated in Figure 1.

Sometimes the gallbladder is so distended with bile and stones that it should be opened and the stones removed before the dissection from the fundus to the cystic duct is done.

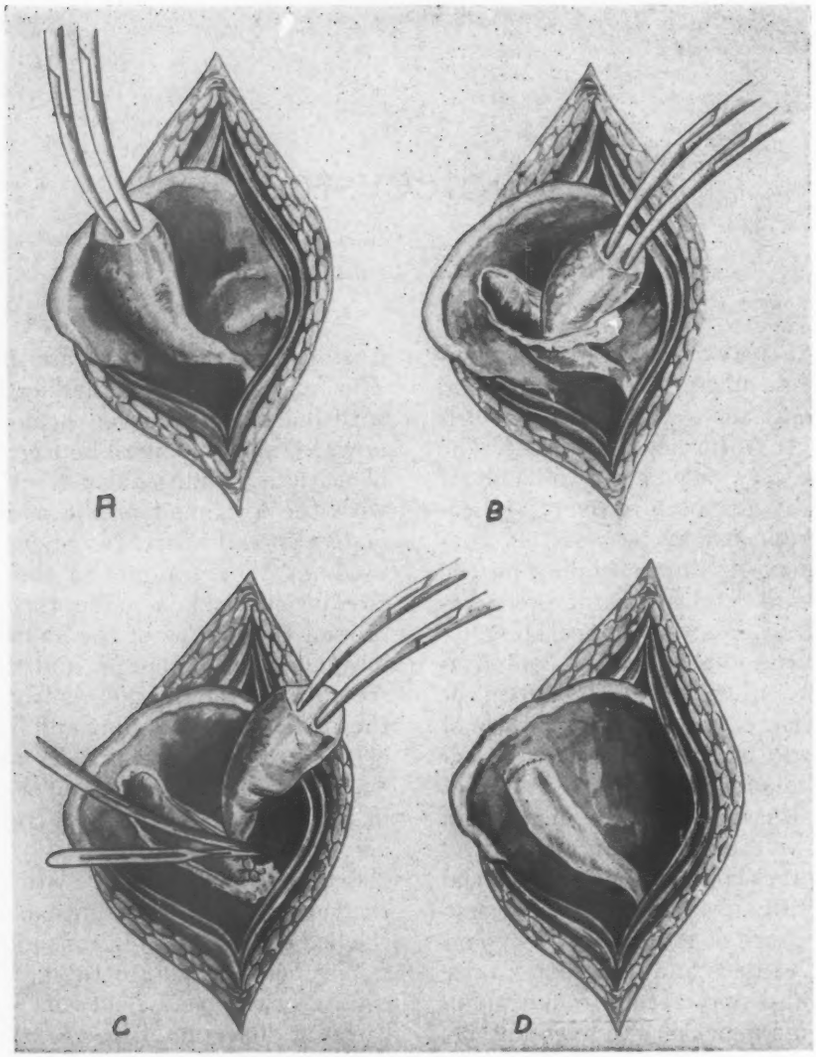

FIG. 1. A, shows two clamps grasping the fundus and a circular incision through the serosa around the fundus. B, shows progress of dissection of serosa from underlying layers. C, shows exposure of cystic duct, which is doubly ligated with No. 0 chromic ligatures. A clamp is placed just distal to ligatures and a knife is ready to sever the cystic duct. D, shows serosa sutured over denuded gallbladder bed with No. 00 chromic running stitch.

After opening the gallbladder, the left index finger is introduced to search for impacted stones and to assist in the dissection down to the cystic duct, as described by Schein and Hurwitt [4]. I have been using this technic successfully for several years.

When the gallbladder wall is edematous or subacutely inflamed, it is easier to find a cleavage plane, and the inner coats can be removed without much difficulty. In such a case, a medium Penrose drain is left in the gallbladder fossa, and the thickened peritoneum is sutured loosely around the drain which is brought out through the same stab wound as the large, extrahepatic Penrose drain. When the edema is very extensive around the cystic duct, it is cut but not ligated and a soft rubber tube is introduced in the gallbladder fossa and brought out through a stab wound; biliary drainage lasts only a few days.

The common duct is palpated but is not opened unless stones are felt, or unless there is a history of jaundice with chills and fever. I believe that small common duct stones pass spontaneously when cholangitis and edema subside following the removal of a diseased gallbladder,

and that more harm than good is done by frequent exploration of the common duct. Bell [5] is of the same opinion, saying that in many cases common duct exploration is being performed unnecessarily and unwisely.

After the intra-abdominal work is done, a large Penrose drain without the gauze wick is placed just below the liver and brought out through a stab wound, about 4 cm. lateral to the main wound. The parietal peritoneum is closed with a running suture of No. 0 chromic catgut and the muscle is approximated loosely with No. 0 plain catgut. The fascia is closed with interrupted No. 24 cotton, the fat with No. 00 plain catgut, and the skin with continuous fine cotton or dermalon.

In the past twelve years I have performed 200 cholecystectomies using the aforementioned technic without injuring the common duct and with only one death. Postoperative hernia developed in three patients who had serious infection in their wounds. The average period of hospitalization after surgery has been seven days, and the postoperative course has been usually very smooth and uneventful. Occasionally a moderate elevation of temperature occurred after removal of the Penrose drain, but this responded promptly to antibiotics. All of these patients have been followed up postoperatively and none have complained of the so-called postcholecystectomy syndrome.

SUMMARY AND CONCLUSION

Removal of the gallbladder from the fundus to the cystic duct, with preservation of its peritoneal coat, is a safe and efficient operation not followed by postoperative complications.

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Sterile Equipment and Method for the Medical Artist in the Operating Room

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THE medical artist with non-sterile equipment poses a problem when he enters the operating room. Both he and the operating room personnel are apprehensive lest he contaminate the sterile field. (Fig. 1.) Such a contamination, if it occurred in a critical phase of an operation, could mean tragedy [1].

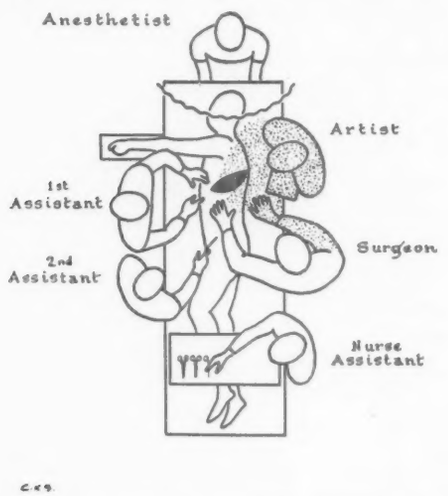

FIG. 1. Area of possible contamination indicated on diagram by stippling. The artist is contaminated by his non-sterile equipment, and because of his proximity could transmit the contamination to other members of the surgical team.

To circumvent this difficulty, a method has been developed for sterilizing the artist's equipment. The artist follows routine "scrub" procedure before entering the operating area and, using the sterile equipment, he becomes a non-operating member of the scrubbed-up surgical team.

MATERIAL AND METHOD

Three sheets of light gauge aluminum, 9 inches by 12 inches by 1/32 inch, are mounted on an all metal clip board. (Fig. 2.) The aluminum sheets provide adequate drawing surface and yet can be autoclaved. The lead is removed from an ebony® pencil (a type whose graphite will withstand the autoclave temperatures), and is inserted into an adjustable all metal holder that can be sterilized.

Small towels, the type used by surgeons to dry the hands, are placed between the aluminum sheets and on the top sheet; the upper edges of the towels then are fastened under the edge of the clip. (Fig. 2.) The towels allow the steam to penetrate to all surfaces of the aluminum sheets. The holder containing the ebony lead is attached to the top of the clip board with a rubber band. The complete package with board, aluminum drawing sheets, pencil and towels is wrapped in four thicknesses of muslin (Fig. 3), and is autoclaved for one-half hour at 250°F., as recommended by Walter [2,3]. Two such kits are kept available in the sterile set-up room in the surgical pavilion for use by the medical artist when he is called to the operating room.

COMMENTS

The surgeon no longer has to delay the surgical procedure to step back and allow the artist to observe at close quarters while he him-

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Sterile Method for Medical Artist in Operating Room

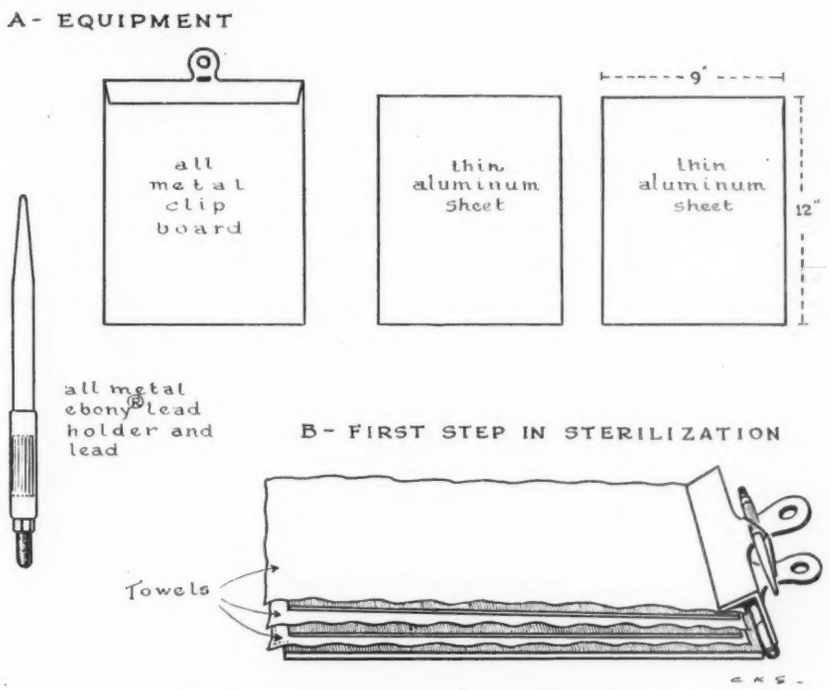

FIG. 2. Equipment constituting sterile kit for use by medical artist.

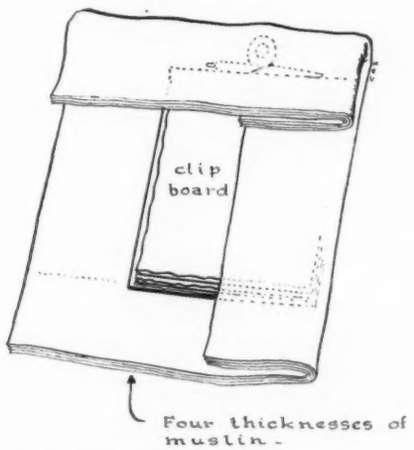

FIG. 3. Method of wrapping equipment for autoclaving or sterilization.

self and all other members of the surgical team scrupulously avoid any contact with the artist. With sterile equipment and method it now is possible for the medical artist to observe and to sketch without jeopardizing or disrupting the surgeon's actions or the aseptic routine of the operating room.

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Carotid Sinus Hypersensitivity Associated with Tumors in the Neck

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SINCE Parry [1] in 1799 first recorded his observations that the pulse could be slowed by strong pressure over one of the carotid arteries, our current concept of the carotid sinus reflex has gradually been evolving. Exaggeration of this response, together with hypotension, to the point of cerebral ischemia and spontaneous dizziness or syncope constitutes hypersensitivity of the carotid sinus or "carotid sinus syndrome."

Weiss and Baker [2] have presented an exhaustive review of studies in this field up to 1933, with an analysis of their own observations. In fifty normal subjects mechanical stimulation of the carotid sinus produced no significant fall in the systemic blood pressure, while in forty-two hypertensive and thirty-six arteriosclerotic patients the fall in pressure was greater in frequency and degree and the cardiac slowing seemed more intensified. In their fifteen cases of carotid sinus hypersensitivity, all patients complained of spontaneous dizziness or fainting attacks which could be reproduced by pressure over one of the carotid sinuses. In six (40 per cent) cases there was aneurysmal dilatation of one or both sinuses, and in three (20 per cent) cases a small tumor was found to be pressing on the sinus; in the remaining six cases (40 per cent) no gross abnormality was detected.

The coincidental occurrence of tumors of the neck and mediastinum with the development of hypersensitivity of the carotid sinus has not been greatly emphasized; it was brought to my attention with dramatic intensity by a development within my own family circle.

CASE I. This thirty-seven year old housewife began to have spontaneous fainting attacks in 1944. These attacks were particularly prone to occur soon after arising, and could invariably be produced by elevating the arms above the head. The systolic pressure would drop below 100 mm. Hg and the pulse rate would be retarded usually to below 60. Atropine taken three to four times daily would almost completely prevent the attacks.

Examination was essentially normal except for moderate enlargement of both lobes of the thyroid without evidence of toxicity, and a fibroid uterus. Hysterectomy was performed in 1947 in the hope of alleviating the syncopal attacks but no such benefit was obtained. It was noted that pressure over either carotid sinus would induce syncope.

In 1952, after adequate preparation with atropine, thyroidectomy was performed. The goiter was larger than it appeared clinically, with considerable substernal extension. Since that time the patient has never fainted nor taken another atropine tablet. Carotid sinus pressure fails to elicit more than a drop of 5 beats per minute in the pulse rate.

CASE II. A fifty year old sales manager was reading one afternoon in November, 1948; he was lying on his right side, supporting his head on his fist applied under the right ear, when he

suddenly went into a clonic convulsion, falling to the floor and lacerating his scalp. He was transferred to the hospital for diagnostic studies. Examination revealed a florid, well-nourished man whose blood pressure was 170/90 mm. Hg on admission. Rapidly alternating pallor and flushing of the face and neck indicated a labile autonomic nervous system. There was a large diffuse goiter which was especially prominent in the midline. Chest x-ray revealed considerable widening of the superior mediastinal shadow as well as enlargement of the heart shadow to the left. His electrocardiogram was normal except for left axis deviation; pressure on the right carotid sinus slowed the rate to 42, with an immediate sensation of "blacking out." Repeated determinations revealed a normal basal metabolic rate; thyroidectomy was advised but refused by the patient. By means of a large, soft collar and daily intake of atropine he has remained free from further syncopal attacks, although he is distinctly hypertensive.

CASE III. This twenty-three year old housewife was first seen by a surgical colleague on March 19, 1946, at which time she complained of lack of energy, nervousness and palpitation since the birth of her first baby nine months previously. She suffered from insomnia, menorrhagia and there was some loss in weight. Examination revealed a tense young woman with a pulse rate of 132 and blood pressure 140/100 mm. Hg. She had a fine tremor of the hands and visible and palpable enlargement of the thyroid. Her basal metabolic rate four days later was minus 10, which on repetition three days later was plus 5. She was given propylthiouracil for one month and scheduled for thyroidectomy on April 25, 1946.

At that time she was given routine preoperative medication and draped in the operating room. Anesthesia was induced by 4 cc. intravenous pentothal® which was followed by gas oxygen and ether. An elliptic incision was made 2 inches above the clavicle and the muscle was split in the midline. She suddenly became pulseless; coramine® was administered intravenously and adrenalin® was injected into the heart; artificial respiration was maintained for thirty minutes. In spite of these measures the patient failed to revive. Permission for autopsy was not secured.

(This was classified as an anesthetic death. In the light of the two previous cases, would it not be at least as logical to suspect that manipulation of the neck triggered a hypersensitized carotid sinus producing cardiac arrest?)

Curiosity being stimulated by reflection on these three people, an analysis was undertaken of carotid sinus syndrome as recorded in the Robert Packer Hospital during the past five years. Ten cases were discovered. In seven cases hypersensitivity of the carotid sinus was recorded as a primary diagnosis, and in three cases this syndrome was indicated as an associated condition. The primary diagnoses in the latter group were possible carcinoma of the prostate with eczematoid dermatitis of the lower lip, metastatic carcinoma of the cervical and mediastinal region, and erythroderma psoriaticum. A brief review of these cases seems warranted.

CASE IV. A male laborer, sixty years old, was readmitted to the hospital in August, 1955, several months after biopsy of a cervical lymph node had revealed metastatic squamous cell carcinoma, presumably originating in the tonsil. At this time he showed widespread metastatic involvement of the neck and mediastinum but his main complaint was of recurrent dizziness. An electrocardiogram was reported as demonstrating carotid sinus syndrome; slowing of the pulse rate and dizziness were produced by carotid sinus pressure.

CASE V. A sixty-five year old druggist was admitted on October 1, 1954, because of "blackout spells" during the previous five weeks. In 1953, he had undergone total prostatectomy for carcinoma of that organ. Pressure over the right carotid sinus produced symptoms identical with the "spells" for which he was admitted. He was readmitted on November 14, 1954, and again on January 18, 1955, for the same complaints. On the latter occasion he was discharged under a primary diagnosis of metastatic lesion of the neck, although no substantiating evidence for this appeared in the record.

CASE VI. This sixty-three year old citrus grower was admitted on July 12, 1955, for a "checkup." Inquiry revealed a history of at least four transient episodes within the previous month of numbness and almost complete

anesthesia of the left hand and cheek, associated with postural vertigo. There was a palpable tender lump noted in the right side of the neck which was interpreted as a submaxillary node. An electroencephalogram and electrocardiogram were simultaneously performed and prompt slowing of the pulse was produced on right carotid sinus pressure. He was discharged with a primary diagnosis of possible cancer of the prostate and associated eczematoid dermatitis of the lower lip and carotid sinus sensitivity.

CASE VII. A sixty-eight year old insurance agent was admitted to ascertain the basis for spells of unconsciousness recurrent for the past thirty years but which were becoming more frequent. He was troubled with "sick headaches" to the age of fifty but these had completely disappeared. He volunteered his distaste for tight collars but had not associated this distaste with his presenting complaint.

On examination his blood pressure was 170/110 mm. Hg; there was definite enlargement of the right lobe of the thyroid due to solitary adenoma. X-rays of the skull showed calcification of the choroid plexus and both internal carotid arteries. Carotid sinus pressure produced definite bradycardia, hypotension and a sense of giddiness.

His carotid sinus sensitivity was treated by radiation, 200 r over each carotid sinus every second day for three treatments. On November 21, 1955, he reported that over the previous six months he had experienced but one fainting attack even though he had discontinued taking atropine some months before.

CASE VIII. A fifty-three year old mechanic was admitted in 1955. He had been troubled for five years by spells which would make him "dizzy in the head and vomit." These were sudden in onset and were usually precipitated by sudden turning of the head. Since October, 1954, these spells had become more frequent and of longer duration. In September, 1953, he had undergone thoracotomy for removal of a teratoma from the superior mediastinum.

On examination his blood pressure was 125/85 mm. Hg and his pulse was 64. On electrocardiography carotid sinus pressure slowed his pulse to 36 with the production of dizziness and nausea on two separate occasions. A chest x-ray revealed a few linear shadows in both lower lung fields (probably atelectatic) and emphysema of the left apical region.

CASE IX. This sixty-two year old painter was admitted to determine the cause of his headaches during the previous nine months. These headaches were accompanied by lightheadedness and on one occasion he had fainted completely. He had undergone transurethral resection of the prostate two years previously.

Examination revealed a blood pressure of 120/68 mm. Hg, and a pulse of 68. There was some retinal arteriosclerosis and a marked arcus senilis. Arteriogram was reported as normal but pressure over the carotid sinus reduced the pulse rate "to 50 per cent" with accompanying sensations of giddiness. Paredrine® was prescribed but the efficacy of therapy was not noted.

CASE X. A fifty-one year old housewife was admitted with a history of mild dermatitis since 1931. She had always experienced episodes at three to four month intervals which were characterized by "shaking" and clouding of the sensorium "as if everything were far off." A tentative diagnosis of epilepsy had been made. While in the hospital she had a seizure and fell to the floor; subsequent neurologic examination was recorded as negative. Pressure applied over the carotid sinus resulted in a momentary sensation of "passing out" followed by a crying spell, but no drop in pulse rate or arterial pressure was obtained. A letter to the referring physician states "sensitive carotid sinus on right; rapid turning of head to the right produces syncope."

CASE XI. A fourteen year old schoolgirl was admitted with a complaint of frontoparietal headaches during the past two years, occurring two to three times weekly. On the day of admission she had stubbed her toe and "blacked out"; she was unable to recall anything for the next ninety minutes. No convulsion, nausea or vomiting were noted.

Comments on her chart read as follows: "Sinus bradycardia (pulse rate 62) . . . the whole picture seems to be due to stimulation of the carotid sinus . . . " She had several attacks of syncope while in the hospital and on further investigation it was noted that bradycardia was continuous and the pulse rate was rarely over 40. Attempts to reproduce her

syncope with carotid massage and ocular pressure were unsuccessful; however, attempts at blocking with paredrine and atropine raised her pulse rate to 60 or 70. The diagnosis was "irritable carotid sinus syndrome."

CASE XII. A thirty-two year old housewife was admitted for study of her headaches, palpitation and substernal pain of eleven months' duration. The case record is sketchy but a letter to the referring physician states: "Both Dr. K. and I tried to reproduce episodes by carotid sinus manipulation and pressure and though we were unable to actually reproduce them, it seemed that we were, nevertheless, able to definitely alter her cardiac rate by carotid arterial pressure."

CASE XIII. This fifty-six year old man was admitted with undescribed complaints and discharged with a diagnosis of carotid sinus syncope plus complete left bundle branch block. It is recorded that pressure on either carotid sinus produced slowing of the pulse and dizziness. He was given a prescription for paredine but his response is unnoted.

COMMENTS

Alpers [3] points out that a distinction should be made between the carotid sinus syndrome and the hyperactive carotid sinus reflex. The former designation should be reserved for patients who experience spontaneous attacks of dizziness, syncope or convulsions due to this mechanism which can be reproduced at will by pressure over the hypersensitive sinus. Most patients with an active cardioinhibitory reflex of the carotid sinus do not have such attacks.

It would seem that in the last four cases here reported, the diagnosis of carotid sinus syndrome was not entirely supported by the recorded evidence. Weiss classifies this syndrome into three types.

(1) The vagal type which is characterized by dizziness, faintness and weakness produced by cerebral anoxia from cardiac inhibition (standstill or sinoauricular or AV block) and a fall in arterial pressure. These attacks may be prevented by atropine or epinephrine therapy.

(2) The depressor type, in which cardiac inhibition is not prominent but in which a fall in arterial pressure due to vasodilatation is the major factor. In this case epinephrine or ephedrine therapy is most effective in aborting the attacks.

(3) The cerebral type, in which unconsciousness and convulsions, which are reproducible by carotid sinus pressure, seem to be unassociated with changes in the cardiac rate or arterial pressure. Denervation of the sinus or radiation therapy thereto seem most effective in these cases.

Case X may be considered as an example of the cerebral type although the confirmatory evidence leaves much to be desired. Case XI seems more suggestive of vagotonia than true carotid sinus syncope. In Case XII, symptoms could not be reproduced by manipulation and Case XIII provides so little information that evaluation seems impossible.

Cases IV through VIII are of special interest in that they are all associated with tumors in the neck and mediastinum. These include two metastatic tumors of the neck, a thyroid adenoma, an enlarged submaxillary node and a previously operated teratoma of the superior mediastinum with residual apical emphysema.

In consideration of the last ten records, even if the diagnosis in the questionable examples is conceded, one-half of these cases of carotid sinus hypersensitivity were associated with tumors or enlargements of some type in the neck or mediastinum. The mechanism whereby such conditions could be expected to increase the normal sensitivity of the carotid sinus reflex is rather obscure. As has been already indicated, aneurysmal dilatation of the sinus is often associated with this phenomenon; increased intra-arterial pressure in these cases may be assumed.

Anatomically, the inlet of the thoracic cage, which is constituted by the first thoracic vertebra, the first rib and the manubrium, is a rigid structure providing little opportunity for expansion. Tumors of the neck encroaching on this area could be expected to increase the general tissue tension of the neck as well as interfere with the dynamics of circulation therein. One might suspect that chronic pressure on the carotid sinus, whether intra- or extravascular, initiates readjustment of the sensitivity threshold of this organ, giving rise to the phenomena of hypersensitivity.

From a practical standpoint, this observation is not without importance. If it may be assumed that vulnerability to carotid sinus hypersensitivity is enhanced by growths in the neck, then

surgery of the neck, particularly thyroidectomy, assumes an increased element of risk in such cases. In the consideration of such surgery, carotid sinus pressure should be applied and the effects on the heart rate and rhythm should be observed as well as the arterial pressure. If hypersensitivity can be demonstrated, the surgeon and anesthetist are at least forewarned, and full atropinization should be included in the preoperative preparations.

SUMMARY

1. Ten cases are presented of hypersensitivity of the carotid sinus from the records of the Robert Packer Hospital during the past five years.

2. Five cases (50 per cent) were associated with space filling enlargements or tumors in the neck and mediastinum.

3. The possible mechanism of hypersensitization of the carotid sinus by increased pressure in the neck is discussed.

4. The added risks of cardiac asystole and other reflex disturbances from this mechanism during surgery of the neck are indicated in order that proper precautions, particularly atropine inhibition of such effect, may be provided by the surgeon or anesthetist.

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Hereditary Small Intestinal Polyposis with Intussusception and Oral Pigmentation in Two Generations: Peutz-Jeghers Syndrome

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A well established clinical entity [7] characterized by the association of gastrointestinal polyposis and melanin deposits on the oral and buccal mucosa, initially considered exceedingly rare, has been described in the literature with increasing frequency since 1949; yet up to August, 1956, a total of only thirty-nine proved cases of this syndrome has been reported of 372 cases of intestinal polyposis. In the case to be described the association of the external signs with the internal pathologic condition was not recognized at the time of examination, leading to delay in diagnosis and treatment; consequently it would seem advisable to continue to call the attention of the medical profession to this interesting and unusual syndrome. Waugh [22] presented an excellent film on the Peutz-Jeghers syndrome at the Clinical Congress of the American College of Surgeons in November, 1955.

Historical description of the syndrome is well discussed in the literature and need only be summarized here. Hutchinson [6] noted and reported the unusual black pigmentation spots on the face and oral mucosa of twin girls, and in 1919 Weber [23] followed up with the report that one of the twins died at the age of twenty with intussusception, proved at surgery, although no notation of polyposis was made and there is no record of autopsy. Jeghers [8] has recorded that the second twin died of carcinoma of the breast at the age of fifty-two, apparently free from gastrointestinal symptoms during her life. Peutz [12] in 1921 was the first to recognize association of melanosis of the lip and buccal mucosa with polyps of the gastrointestinal tract and showed the hereditary nature of the syndrome, later studied by Jeghers et al. [9] who found the syndrome inherited as a mendelian dominant. The condition occurs with equal frequency in the sexes and patients are characteristically dark-haired with brown or deep blue eyes. The pigmentation varies from tan to pale blue to deep black, in spots 1 to 5 mm. in diameter. These spots were differentiated from freckles and lentigines by Berkowitz [1] who states that the melanin deposits are characteristically confined to the vermilion of the lips, especially the lower lip, and buccal mucosa, and sometimes the hard palate and gums. Perioral, perinasal and periorbital pigmentations as well as lesions on the fingers and toes were frequent but not necessary to the syndrome. The melanosis is generally found within six months of birth and does not vary with the degree of exposure to sunlight.

As originally described, the association of oral pigmentation with gastrointestinal polyposis was limited to the more rare situation of small intestinal polyps. Case reports have since revealed that the polyposis does involve the stomach and/or colon, and malignancy has been a complication in approximately 20 per cent of the cases [1]. Polyps in the ileum occur most frequently, however, and are generally benign. Since there are no proved cases of the characteristic pigmentation without polyps [9] and since gastrointestinal polyposis without pigmentation with a genetic pattern has been observed much more frequently, one can only speculate on the possible mechanism to explain

the strange association of the two features; but whatever the relationship, it is only important to know that when one is observed the other should be searched for. Typical signs and symptoms consist of recurrent colic, gastrointestinal bleeding and anemia, and a diagnosis of intestinal obstruction and intussusception is made. The most common manifestation is recurrent intussusception in the second or third decade of life [*2,10,16*]. A patient studied by Stewart and Storey [*17*] underwent nine laparotomies over a period of years for polypectomy and intussusception and eventual colectomy with preservation of the rectal segment for anterior anastomosis. Incidental appendectomy during one operation on this patient revealed two small adenomas in the lumen of the appendix. In a case reported by Jeghers et al. [*9*] one polyp was revealed every 50 to 60 cm. throughout the jejunum and ileum at autopsy. In the case reported by Young [*26*], the jejunal polyp at surgery entered the intussuscipiens last and was trapped by a constricting ring.

Intussusception, *per se*, is of course far more common outside this syndrome, and Washburn [*21*], in describing a case due to polyps of the ileum (evidently not associated or recognized as associated with oral pigmentation), remarked that intussusception of the small bowel was exceedingly rare. From 1925 through 1945 there were ninety-five cases of intussusception among 141,580 admissions to Cook County Children's Hospital in Chicago [*15*]. It is the most common, if not the most serious, cause of intestinal obstruction in childhood. Only 5 per cent of cases occur in adults and 78.5 per cent occur in infants under the age of two years [*13*]. In infants a discernible mechanical factor was present in just 5.4 per cent of the total reported, represented by Meckel's diverticulum in twenty-nine cases, polyps in four cases and lymphoma in two cases. In adults a definite mechanical inciting factor was present in the majority of cases, such as lipoma, fibroma, adenoma or malignant neoplasm. The tumor acts as a bolus of food which peristalsis tends to force down through the intestine. The base of the tumor becomes inverted when traction on the mass is greater than the resistance of the musculature at the base, and further traction turns lateral invagination into a complete intussusception. When a picture of intestinal obstruction presents, the process is already far advanced, and many of the cases of intussusception due to polyposis reviewed in the literature were diagnosed at autopsy.

CASE REPORT

C. R., a thirteen year old white boy was admitted to the Hanover General Hospital on October 7, 1955, with a chief complaint of "pain in stomach." History revealed that approximately twenty-four hours previously sudden pain had developed in the periumbilical region accompanied by nausea and vomiting one time. Pain had remained intermittent and colicky since onset and the patient had received some relief from "antispasmodic" administered by the family physician. There was a history of previous similar episodes of less severity during the past two years. Bowels had been regular and moved twelve hours prior to admission; there has been no diarrhea or melena. There were no urinary or cardiorespiratory symptoms and no history of fever or chills. Except for tonsillectomy and adenoidectomy at age nine, there had been no previous operations or injuries. The patient had had measles, mumps and chickenpox in earlier childhood.

On physical examination temperature was 97.8°F., pulse 100, respirations 22, blood pressure 122/68. The patient was somewhat apprehensive but cooperative to examination and of normal intelligence. The eyes and hair were dark and the skin of dark complexion. There was no cyanosis, icterus or pallor present. There were spotty pigmentations over the lower lip and on the mucous membranes underlying the right cheek. (Fig. 1.) The tongue and gums were free of the pigment. On questioning, the patient stated his father had similar pigmentation and although not revealed at this time, his father had died after surgery for intussusception in 1941 prior to the birth of his son. Examination of the neck and chest were normal. Abdominal findings revealed tenderness and moderate voluntary guarding just inferior and to the right of the umbilicus. The right lower quadrant was not tender on deep palpation. There was no rebound tenderness and peristalsis was normal. There were no masses, hernias or scars. Rectal examination was negative.

Complete blood count following admission showed: red blood cells, 3,950,000 per cu. mm.; white blood cells, 18,200 per cu. mm.; hemoglobin, 11.8 gm. (74 per cent); and 95 per cent polymorphonuclear neutrophils including 41 stab forms, 4 lymphocytes and 1 monocyte.

1A 1B

FIG. 1A and B. Note spotty pigmentations near the vermilion border of the entire lower lip and extending on to the perioral skin in the right and left corners of the mouth.

The patient could not void for specimen examination and was not catheterized.

A diagnosis of "acute abdomen," probably acute appendicitis or Meckel's diverticulitis, was made and the patient was operated on one hour after admission. Under general anesthesia a McBurney incision was made using catgut technic. On opening the peritoneum, a moderate amount of clear straw-colored fluid was evacuated. The cecum was easily found, and the appendix was only slightly enlarged and edematous and contained two definite fecaliths. Appendectomy was performed, inverting the stump with linen purse-string suture. The lower 12 inches of terminal ileum were normal, but the small bowel proximal to this was distended and seemed to contain a dark fluid slowly passing down the lumen. The operator ordered the anesthetist to pass the stomach tube and evacuate the stomach, but only clear yellow fluid was obtained. The tube was removed and the incision was closed in layers without drainage.

On the first postoperative day the patient vomited a large amount of dark bile-stained liquid material and was placed on parenteral fluid therapy. An enema was effectual for flatus only. A repeat blood count revealed red blood cells, 2,340,000 per cu. mm.; white blood cells, 10,650 per cu. mm.; hemoglobin, 7.8 gm. (49 per cent); and 48 per cent polymorphonuclear leukocytes with 39 per cent transitional forms, 11 per cent lymphocytes and 2 monocytes. Temperature was 99°F. and pulse was 100. On the second postoperative day temperature was 100.4°F. and pulse 120, and the patient began expelling dark blood per rectum along with actual feces. Blood pressure was 142/76. Vomiting continued intermittently and on October 10, 1955, the patient was placed on continuous nasogastric suction via Levin tube and was given 500 cc. of whole blood transfusion. Urinalysis done on the first postoperative day and repeated on October 12th was negative except for 1 plus albumin. A pathologic report on the appendix described two large fecaliths, and the statement was made that the appendix was thick-walled but grossly and microscopically negative for acute inflammatory changes. The patient continued to expel dark stools and blood clot per rectum, but nasogastric suction yielded only normal gastric and duodenal contents in excessive amount and a bleeding duodenal ulcer appeared unlikely. Temperature continued at 100°F., pulse was 120 and blood pressure was 130/80.

On October 13th, six days postoperatively, a scout film of the abdomen revealed marked distention of the stomach and a markedly dilated loop of small bowel which appeared to be jejunum, each containing large fluid levels. The remainder of the small bowel was collapsed and normal. (Fig. 2.) A diagnosis of high mechanical intestinal obstruction was made, probably due to volvulus or intussusception. At this time it was first revealed that the patient's father had died at the age of twenty-two following operation for intussusception, and that he too had similar pigmentations on the lower lips.

The patient was returned to the operating room following x-ray examination. An upper left transverse incision was made under general

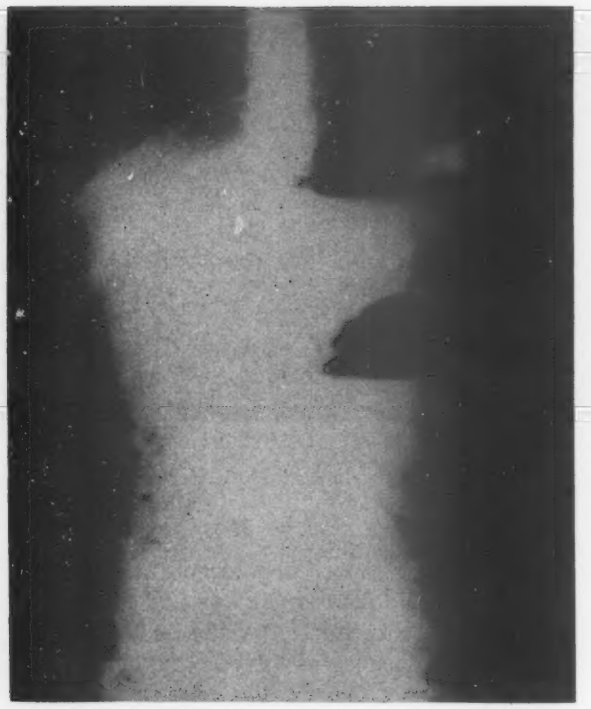

FIG. 2A. Anteroposterior upright scout film of abdomen revealing distended stomach and loop of small bowel (jejunum) with fluid levels.

FIG. 2B. Posteroanterior flat plate of abdomen showing extreme dilatation of jejunum just distal to the ligament of Treitz and inferior to the gastric shadow. At operation this portion of jejunum measured 10 cm. in diameter.

FIG. 3A. Coil of resected small intestine showing polyp measuring 7 cm. at distal end of intussusceptum.

FIG. 3B. Close-up view of polyp in Figure 3A, showing fungoid tip measuring 3 cm.

anesthesia, dividing the rectus muscle and a part of the internal and external oblique. When the peritoneum was opened a large segment of distended small bowel measuring about 20 cm. presented itself beneath the incision. This bowel was found to be dilated jejunum and measured 10 cm. in diameter, the distention extending to the ligament of Treitz. Just distal to the distention was a narrow area of constriction followed by a dark gangrenous segment of bowel containing the intussusceptum and measuring about 15 cm. There was a recent

perforation in the intussuscipiens leaking dark bile and brown intestinal contents. Any attempt to reduce the intussusception only forced more leakage from the perforation. Distal to the limits of the intussusception the small bowel was collapsed. It now became obvious that the dark drainage seen descending the bowel at appendectomy was probably blood and bile from a beginning intussusception. Without further delay, the loop of bowel involved in the process was resected as far proximal as the ligament of Treitz and approximately 6 cm. distal to the intussuscipiens. The distal end of the jejunum (or early ileum) was closed in three layers and a two-layer end-to-side anastomosis was performed, this technic being necessitated by the greatly distended proximal limb of intestine and relatively small diameter of the distal limb. The defect in the mesentery was closed without difficulty. No further examination of the bowel was made and the wound was closed in layers around one cigarette drain brought out through the lateral aspect of the incision. The specimen was opened prior to closure of the abdomen and a large polyp was found at the distal end of the intussusceptum. (Fig. 3.) The pathologic report was as follows: "12 cms. from the distal end of the resected bowel is a long polyp measuring 7 cms. in length with a fungoid polyp, 3 cms. long on the one pedicle; the remainder of bowel is essentially normal except for vascular necrotic changes and a perforation through the wall measuring 0.5 cm. Microscopic section reveals benign adenomatous mucosal polyp."

Postoperative progress was excellent and convalescence was uneventful. Nasogastric suction was discontinued in forty-eight hours when the patient had a normal stool. His temperature fluctuated between 98.6°F. to 99°F. for the remainder of hospitalization, and a weight loss of 13 pounds since admission was partially restored at discharge on October 27th, twenty days after admission and two weeks postoperatively.

The patient was re-examined on December 30th, 1955, approximately eleven weeks postoperatively and stated he was in good health; the weight loss had been completely restored and he was asymptomatic. Bowel movements were regular and there had been no rectal bleeding or tarry stools. Barium enema studies at this time showed a colon free of polyps, but an upper gastrointestinal film revealed numerous gastric polyps and a small bowel pattern apparently free of additional polyps. (Fig. 4.) The anastomosis could not be differentiated.

FIG. 4. Spot film of stomach, posteroanterior view, taken after barium meal eleven weeks postoperatively and demonstrating the polyps above the greater curvature margin.

It is a consolation to know that intestinal polyps and the hazard of possible intussusception are no longer a problem in this patient, but it is believed that the gastric polyps will warrant surgery because of their tendency to malignant change in later life. The patient will be approached with this recommendation in the near future.

SUMMARY

1. A case report illustrating the syndrome of intestinal polyposis in a thirteen year old boy associated with characteristic melanin spots on the lips and oral mucosa and diagnosed at emergency surgery for intussusception has been presented, and the family history of death of the father with similar oral pigmentation at the age of twenty-two, following surgery for intussusception, has been noted.

2. With the addition of this case to the

medical literature there are still less than fifty reported cases of multiple gastrointestinal polyposis associated with oral pigmentation.

3. The eponym "Peutz-Jeghers syndrome" has been used to describe the association of one sign with the other after the original observations of the former and the definitive description by Jeghers and his colleagues.

4. Polyposis of most of the entodermal structures can participate in the syndrome [3].

CONCLUSION

Knowledge of the Peutz-Jeghers syndrome may simplify a difficult diagnostic problem as in recognizing the external manifestations which indicate a possible cause for an internal abdominal situation. According to Weber [24], elective surgery should be recommended in an asymptomatic child because of the probability of future intussusception and/or possibility of malignancy present. Nevertheless, in small bowel polyposis this essential segment of bowel cannot be removed *in toto* as the colon can, and it is virtually impossible to resect all the polyps locally when profuse in number. In Crumpacker's opinion [3], it is unwise to attack such lesions until symptoms intervene.

After a thorough review of the literature and intensive study of the case reported herein I am inclined to agree with Weber and others and would recommend elective definitive surgery in spite of its limitations, once the diagnosis is made. This would preclude such catastrophes as emergency resection for gangrenous intussusception as well as reduce the incidence of malignant degeneration which has been shown to be present in 20 per cent of all cases reported.

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Intussusception and Plication

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POSTOPERATIVE symptoms, complaint and disability may have no relation to the original disorder, even when they are apparently identical. Reason advises that continued symptoms indicate a continuing pathologic condition. Good physicians may be too self-critical and too willing to read failure into the return of a complaint.

We forget easily that the human anatomy has no limited list of unique symptoms for each disorder. The same complaint may be aroused by a variety of dissimilar causes and the patient sees all causes as one and the same.

Apropos of this, tangentially, a complete physical is no more than a dated conclusion; it has little bearing on the conditions the day before or the day after the examination. The earliest symptom has, on occasion, been buried under the weight of many normal readings made a few weeks previously.

This is the discussion of a rare occurrence subsequent to surgery. The surgeon considered it to be a mark of his technical failure because symptoms and complaint were identical to those preoperatively. There was, however, no connection between cause of symptoms and pathologic condition. Surgery had been successful, and photographs taken during the operation demonstrated the unusual cause of the complaint and its successful correction.

The patient had been operated upon for peritonitis almost one year earlier. At that time she had had partial and complete obstructions scattered along the small bowel around multiple abscessed areas. These pools of pus were surrounded by intestinal and mesenteric structure [*7*].

According to plan, the involved intestine was liberated by dissection, all exudates were aspirated, the abdomen was carefully cleansed, and all small bowel involved in the inflammatory zone was continuously plicated. Parts of the small bowel were free of all evidence of congestive turn; these were not plicated [*6,10*]. The terminal ileum was free of peritonitis.

Thomeret of Paris advocates plication of the entire small bowel in all such cases [*14*]. We have not followed that plan. The difference between the two views can be resolved by careful study of mortality and morbidity statistics. Our mortality and morbidity statistics have been reported elsewhere [*6–8,10*].

The patient, a middle-aged woman, made an uneventful recovery following plication. She remained symptom-free and apparently was perfectly well for some months. Then her symptoms returned.

She experienced sudden bouts of pain, gaseous distention, nausea and vomiting. There was no fever. Intubation immediately relieved all symptoms. X-ray studies were made and no obstruction was demonstrated then, but observation during subsequent attacks proved the intermittent existence of obstruction. The sudden, obstructive incidents seemed to leave no residual evidence immediately after cessation, but they increased in frequency and severity.

The matter was discussed with the patient and she agreed that it would be more desirable to undergo surgery than to continue with her unpredictable, recurrent disability.

Consultation for the time of surgery was requested. The patient was prepared properly and underwent surgery in excellent condition with no evidence of any degree of obstruction at that time.

The surgeon and I agreed on the basic facts [*10,11*]. Plication of the intestine for peritonitis prevented the return of obstruction that had been multiple at each site during the former attack of peritonitis. There had been many areas of angulated, edematous bowel with multiple obstructions due to inflammation at each such site. Plication, after resolution of the disease through dissection, prevented uncon-

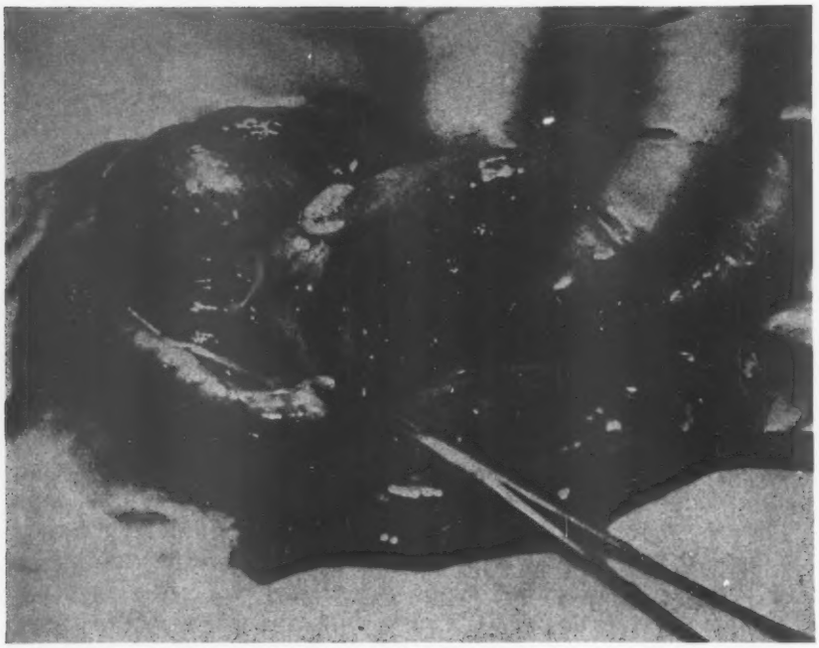

FIG. 1. The terminal ileum has been grasped between the fingers with the cecum in view. The appendix had not been removed at the first operation because it was not part of the cause of the original peritonitis and the condition of the patient was too serious. The wrinkle at the ileocecal ring is evident where the intussusception has been artificially reproduced. The cecum and the ileum have been lifted into the operative field for photographic purposes to illustrate the condition as we first saw it.

trolled adhesion-angulation and subsequent obstruction. After extensive abscess involvement of the small bowel, there may be enough destruction of the intestinal wall to forecast cicatricial contracture with late developing mechanical obstruction. We have seen this occur twice some years after plication for very severe peritonitis. After thirty-six years' experience, the rarity of this accident does not deny its existence in any case.

We anticipated such a complication here without any evidence. In a search for the possible cause associated with the original attack of severe peritonitis, we also examined the technic of the original surgical attack.

Peritonitis had been of a most severe degree. Not all of the intestine had been plicated. We presumed that new adhesions might have involved new and unanticipated areas of the undamaged, and therefore unplicated, small bowel. Thomeret considers this possibility to be reason enough for the plication of the entire small bowel in all cases. This has not increased his operative mortality rate and it has eliminated secondary surgery [*17*].

In our experience with more than 1,000 cases so plicated, the accidental involvement in cases of adhesions, subsequent to the initial plication and requiring secondary operation, has been less than one-half of 1 per cent. Statistically this is very encouraging, but to each patient statistics read 100 per cent one way or the other.

At the time of this second operation, the surgeon mentioned previously requested that the writer be the surgeon and that he be the assistant.

I have adopted a routine procedure in the approach or study of the pathology of peritonitis [*5,7,10*]. If possible, the ileocecal junction is considered the starting point for the study of the adhesions and their dissection-resolution.

At this second operation the abdomen was opened in the midline. There was no adhesion of intestine to the anterior abdominal wall. The regeneration of peritoneum across the surface of the plicated loops of intestine had followed the inflammatory adhesion sheets, as has been noted and photographed elsewhere

FIG. 2. The completely reduced intussusception shows no peritoneal adhesion, ecchymosis or other evidence of what had just been seen. It is perfectly obvious that no diagnosis could be made by x-ray or inspection with the abdomen open. If we had not observed temporary sliding of the terminal ileum into the cecum, I question the value of what might have been done at any operation.

[*10*]. The ileocecal region came into view immediately (Fig. 1), and it was during this first minute of the operation that we observed the pathologic condition causing the symptoms.

The terminal ileum had not been involved in the original attack of peritonitis, and had not been plicated. Now we saw the terminal ileum invaginated into the cecum for a distance of 2 inches. It was not adherent. As we watched, we saw this intussusceptum reduce itself spontaneously. (Fig. 2.) Perhaps opening the abdomen changed the intra-abdominal pressures enough to bring this about.

The intussusception disappeared completely. There was no evidence of peritoneal irritation on the ileum or cecum. If we had operated a few moments later, there would have been no possible evidence as to the cause of this woman's symptoms. I am sure, therefore, they would not have been treated.

We then inspected the full length of the small bowel. The plication done by the surgeon had served perfectly. Where peritoneal destruction had been minimal, he had sutured by running continuous catgut suture only through the peritoneum. In the months that had passed since plication, the hydrodynamic activity of peristalsis had stretched the intestinal peritoneum. Many wings of plication had disappeared, leaving only the slightest evidence on the peritoneum with no fiddle-strings, bands or sheets of adhesion [*11*].

Some men have said that this disappearance of a wing of plication is a failure of plication. We disagree. We believe this to be a clear mark of the success of plication. We have called attention to the surgeon's control over the future of his wings of plication and the reasons for his choice elsewhere [*10,11*].

This disorder and the resulting symptoms were due to the fact that the ileocecal junction was marked by a firm ring about 1½ inches in diameter. This rigidity permitted the sliding, recurring intussusception on occasion. At no time had there been enough irritation or the continuance of the intussusception to result in local peritonitis. Therefore, no evidence of the disorder remained. Without evidence there is no reason for therapy.

It is conceivable that this patient might have been operated and reoperated upon repeatedly, with the cause of her disorder not being discovered at any time. In the absence of the temporary intussusception there would, of course, be no chance of demonstrating it by x-ray or surgery. Only after continued insult and local injury had brought about some degree of peritonitis with adhesion or fixation could this disorder have been recognized, if not actually seen in action.

FIG. 3. The appendix has been removed by simple ligation. The suture of the ileum in plication is seen as completed. Photograph cannot represent the difference between a simple, peritoneum-deep suture and the one done for permanence [*10*].

The discovery of the condition during surgery certainly was a coincidence of such nature that it can be considered most fortuitous.

The treatment was, of course, very simple and obvious. The terminal inches of the ileum were brought parallel to the ascending colon. The peritoneal coat of the ileum and colon were severed and the raw surfaces sutured in order to effect permanent union between small and large bowel [*11*]. If this is done, as has been described elsewhere, peristalsis will not separate the union and the junction will be permanent. Three continuous wings of plication of the terminal ileum were made, each one planned for permanence. When intussusception exists, plication represents the easiest available, permanent correction if the method of suturing for permanence is followed [*10*]. (Fig. 3.)

Several years have passed and this patient has remained symptom-free.

SUMMARY

A unique complication after the successful treatment of peritonitis has been described. The disorder had no pathologic relationship to the original attack of peritonitis. Symptomatically it was identically associated with the original complaint in the mind of the patient and doctors.

These circumstances point out the complexity of associated pathologic conditions in one patient that have no relationship to like causes. They did have a relationship to the patient's interpretation of symptoms. This complication marks another type of pathologic condition difficult to find either by x-ray or surgery. Intussusception is also difficult to locate when it is incomplete or temporary. Unless it is anticipated and routinely searched for, it can easily be missed.

The treatment of peritonitis and its aftermath of adhesion fixations can be most complex. Intussusception is another added complication.

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Gastric Diverticula and Massive Gastrointestinal Hemorrhage

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TRUE gastric diverticula are relatively rare and are considered to be congenital in origin. These lesions, usually producing no symptoms, are discovered only incidentally, and such symptoms as may occur are non-specific.

In a review of the literature up to 1951 Palmer [1] discussed a group of 138 patients in which a diverticulum seemed to be the source of symptoms. Simple epigastric distress and pain in the lower portion of the chest were the most common presenting complaints in these patients. Serious symptoms, such as acute perforation and hematemesis, were extremely uncommon. In fact, hematemesis occurred in only three of the cases. The infrequency of this symptom, as reported by Palmer and other investigators, has led to the general conclusion that serious hemorrhage associated with gastric diverticula is rare. Because of its rarity, a case of massive and recurrent hemorrhage associated with a gastric diverticulum is presented herein. It serves to illustrate the relation between this lesion and gastrointestinal bleeding.

CASE REPORT

The patient, a seventy-three year old white man, was admitted for the first time to the Roosevelt Hospital, with the chief complaint of hematemesis. He reported that he had been in good health until eleven years previously, at which time he had had a single episode of vomiting bright red and clotted blood. He had not sought medical aid at that time, had been "dizzy" for one week and had then recovered.

The patient was perfectly well and without gastrointestinal discomfort until seven years before admission, when once again there was a sudden onset of hematemesis and tarry stools. On this occasion he was hospitalized, and findings on physical examination included emphysema and a liver palpable four fingerbreadths below the costal margin. Two days after admission he had a sudden hematemesis of 1,000 cc. of bright red blood and was given multiple transfusions. After cessation of the bleeding a gastrointestinal series was obtained which showed only what was interpreted to be a small hiatus hernia. Multiple studies failed to reveal esophageal varices although their presence had been thought likely.

The patient was well until one year prior to the present admission, at which time he was again hospitalized for examination because of a serious loss of weight. Thorough examination revealed pulmonary emphysema, arteriosclerotic heart disease and diverticulosis coli, as well as a diverticulum of the stomach which measured 2 cm. and projected from the lesser curvature near the fundus. Cirrhosis and esophageal varices were specifically suspected to be present in view of the patient's past history, but no evidence of them was found. His loss of weight was considered to be related, in part, to emotional factors.

At the time of admission to Roosevelt Hospital the patient did not report any symptom other than bleeding. Three hours previously he had awakened from sleep with a feeling of nausea and had had a sudden onset of hematemesis. Two more episodes of bleeding occurred, including one while the patient was under observation in the Accident Room, with a total estimated loss of 2 pints of blood.

On admission the patient was thin but well developed, in no acute distress and with no abdominal tenderness. His blood pressure was 100/60, his pulse 80 with occasional premature ventricular contractions, and his respirations 15 per minute. The liver was two fingerbreadths

FIG. 1. X-ray showing diverticulum at the gastro-esophageal junction.

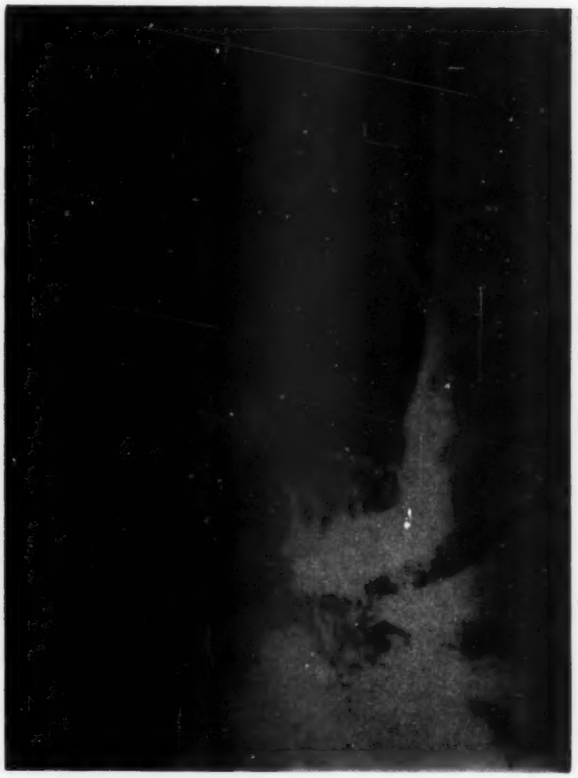

FIG. 2. X-ray showing incomplete filling of duodenal bulb and first portion of duodenum.

down, soft and non-tender. Laboratory studies gave the following results: hemoglobin, 10.5 gm. per cent; hematocrit, 31 per cent; urine, negative; blood urea nitrogen, 35.8 mg. per cent; alkaline phosphatase, 2.14 Bodansky units; total bilirubin, 1.16 mg. per cent; bromsulphalein retention, 5.2 per cent; albumin, 3.68 gm. per cent; globulin, 1.16 gm. per cent; thymol turbidity test, negative; and blood type, A B positive.

Dextran IV was administered to the patient. About four hours later the hemoglobin fell to 9.6 gm. per cent and the hematocrit fell to 29 per cent. There was no change in vital signs and no repetition of hematemesis. The patient received 1,000 cc. of blood in the next twelve hours, after which the hemoglobin rose to 11 gm. per cent and the hematocrit to 33 per cent.

On the morning of the second hospital day the patient had two tarry stools, and after the second, his blood pressure fell to 80/60. Shock blocks were used and blood was again started, with quick return of vital signs to previous levels. At this time the hematocrit was noted to be down to 27 per cent. The patient received another 1,000 cc. of blood in the next six hours and an emergency gastrointestinal series was performed. Examination of the esophagus failed to reveal any evidence of varices or hiatus hernia; however, a diverticulum was noted in the stomach at the gastroesophageal junction. (Fig. 1.) Some coarse mucosal folds in the greater curvature were also noted. The duodenal bulb did not fill completely in its apical portion and the first part of the duodenum also filled poorly. (Fig. 2.) On initial reading, ulceration on the greater curvature of the stomach was suspected. With the possible presence of ulceration and in view of the patient's age, his apparent continued hemorrhage and the difficulty of obtaining his blood type, it was decided to perform an exploratory celiotomy.

At operation on the afternoon of the second hospital day the abdomen was entered through a long midline incision. Exploration revealed no gross abnormality of the stomach, and the duodenum was soft and without scarring. External inspection showed blood in the terminal ileum and colon but nowhere else. The stomach, opened by a long gastrotomy incision, showed some increase in size and number of

FIG. 3. Wall of diverticulum showing gastric mucosa, muscular tissue, widespread hemorrhages, and marked focal lymphocytic reaction.

rugal folds with considerable mucosal injection; however, no active bleeding points were noted. No abnormality was felt in the duodenum and pyloric ring, which were palpated from within and from without. The gastrotomy was then continued up to within 1 inch of the cardia, the area of the suspected diverticulum, which was found at about 2 cm. from the lesser curvature and high on the stomach near the gastroesophageal junction.

To permit visualization and to increase accessibility, the lesser sac was entered and the greater curvature was liberated up to the esophagus. The interior of the relatively broad-mouthed diverticular sac was seen to be studded with grossly hemorrhagic areas, although active bleeding was not seen. This finding and the absence of other pathologic factors indicated without the slightest doubt that the diverticulum was the source of the hemorrhage.

The diverticulum was bound against the stomach wall by serosal covering and it was difficult to dissect it free. However, it was found possible to invert the diverticulum into the stomach, and once inverted, it was excised. The gastric wall defect was closed in two layers, the inner with continuous chromic catgut and the outer with interrupted silk. The gastrotomy was closed similarly and the abdominal wound repaired.

The pathologic report showed that the diverticulum measured about 3.5 cm. in diameter, with a roughened lining and outer smooth surface; that multiple crevices, hemorrhagic in appearance, were present in the mucosa; and that the wall of the diverticulum measured about 2 mm. in thickness. On microscopic section the diverticular wall was shown to consist of gastric mucosa and some muscular tissue, with widespread fresh hemorrhages and marked focal lymphocytic reaction. (Fig. 3.) Diagnosis was "gastric diverticulum with hemorrhage and chronic inflammation of diverticular wall."

Generally, the patient did well after surgery. He was out of bed by the third day and afebrile and without symptoms by the twelfth postoperative day. He was discharged on the sixteenth postoperative day with a diagnosis of gastric diverticulum and gastrointestinal hemorrhage, arteriosclerotic cardiovascular disease, chronic bronchitis and pulmonary emphysema, and mild diabetes mellitus. At the time of discharge the hemoglobin and hematocrit were 13.2 gm. per cent and 40 per cent respectively.

COMMENTS AND CONCLUSIONS

On the basis of location and general appearance, the case presented herein belongs in the category of true diverticula. True and false gastric diverticula are distinguishable by cer-

tain specific characteristics. False diverticula may be located in any part of the stomach, may be multiple and are the result of processes which cause traction and tenting-out of the stomach against an adjacent organ. They may also be the result of incompletely perforating processes which leave pouch-like x-ray defects. True diverticula are apparently congenital lesions which appear more frequently as single lesions and are seen, for reasons not yet fully known, on the posterior gastric wall about 2 cm. from the esophagastric junction and 3 cm. from the lesser curvature.

Gastric diverticula are rarely included in the differential diagnosis of gastrointestinal bleeding because of their relative infrequency. Feldmann [2] found an incidence of 0.02 per cent at autopsy, and a range of 0.0043 to 0.015 per cent has been reported among general hospital admissions [1,3]. In routine gastrointestinal series a range of 0.043 to 0.1 per cent has been noted [1,4].

Although massive hemorrhage in connection with gastric diverticula is rare, bleeding is thought by some investigators to be the most frequent of the serious complications of diverticula which produce symptoms [5]. The authors of the present report, however, consider the basis for this impression somewhat tenuous. In reviewing 124 cases comprising eight separate series since 1938, it was found that melena or hematemesis, or both, were present in eighteen cases. In only three of these, however, did an operation rule out the presence of lesions other than a diverticulum. For example, in one report [3] eight of twenty-six patients had a history of hematemesis or melena, but six of the eight patients had associated gastrointestinal lesions which might have been the site of loss of blood; operations were not performed in the other two cases.

The frequency of gastrointestinal lesions in association with gastric diverticula has been noted by many authors. However, this finding may represent an artifact of selection, as suggested by the much higher incidence of diverticula found in routine gastrointestinal series than that in general hospital admissions.

It must be further noted that no case has been reported of a true gastric diverticulum found bleeding actively at the time of surgery. In the case reported herein there was no active bleeding, although the mucosa of the diverticulum was hemorrhagic. In one reported case [4] bleeding was noted at the time of gastroscopy. The mechanism of diverticular bleeding has been thought to begin with stasis of food particles in the pouch, which leads to irritation and diverticular inflammation. Pathologic reports on excised diverticula [1] frequently indicate inflammatory change, as was true in the present case. Hemorrhage in the diverticular wall has also been reported [7].

It seems reasonable to conclude that while gastric diverticula may bleed, the diagnosis of a bleeding diverticulum is largely one of inference and exclusion. Exploratory celiotomy seems necessary in order to rule out the presence of other lesions. In the absence of this procedure the diagnosis must remain in doubt. The findings that operative exploration of our patient revealed seem to substantiate our conclusion that the diverticulum was the bleeding site. Furthermore, the similarity of previous bleeding episodes in our patient suggests, although it by no means proves, that the diverticulum was the site of recurrent hemorrhage. In this, our case parallels the one reported by Brown in 1938 [6].

The treatment of gastric diverticula is not discussed herein, as it is a topic beyond the scope of this report. Advocates of simple excision [8] and of closed inversion [9] have advanced reasons for their methods of choice. More recently, an abdominothoracic approach [7] has been urged as being superior to the abdominal exposure. The treatment of our patient represents the solution of a specific problem rather than a general approach to the treatment of gastric diverticula. In reviewing the steps of our treatment it was found necessary to open the stomach in order to rule out the presence of bleeding lesions other than the diverticulum. It was then found easier to invert the diverticulum and excise it from within the stomach, rather than obtain exposure of it outside the stomach. Excision seemed indicated in view of the fact that the diverticulum was the apparent source of recurrent hemorrhage.

SUMMARY

1. An unusual case of massive and recurrent bleeding from a gastric diverticulum in which celiotomy was performed has been presented, and a review of the literature has been given.

2. Although minor gastrointestinal bleeding is often ascribed to those gastric diverticula that produce symptoms, the evidence for this

view has been shown in this report to be less well established than commonly thought.

3. It has been pointed out that the diagnosis of bleeding gastric diverticulum can be made only after the exclusion of other more common lesions.

4. Celiotomy is probably necessary before the exclusion of other lesions can be said to be complete.

Acknowledgments: The authors wish to acknowledge with thanks the assistance rendered by Mrs. Rose M. Schweitzer, Editor for Clinical Research, and Miss Edith Baker, Medical Illustrator, Roosevelt Hospital.

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Leiomyoma of the Epididymis

VICTOR R. JABLOKOW, M.D., *Detroit, Michigan,* AND WILLARD C. MEYER, M.D., *Evanston, Illinois*

PRIMARY tumors of the epididymis are very rare, as evidenced by the report of Longo, McDonald and Thompson [*1*], who collected a total of 134 proved cases of tumors originating in the epididymis up to 1949. Of these cases, ninety-eight tumors were benign and thirty-six were malignant. The most common benign tumor was adenomatoid tumor or mesothelioma. The next most common tumor was leiomyoma, which represents 10 per cent of the cases. The authors added nineteen such benign tumors from their clinic to those collected from the literature. Of their nineteen cases, two were leiomyomas and the remaining seventeen were adenomatoid tumors.

CASE REPORT

A fifty-nine year old white man was admitted to the St. Francis Hospital because of a scrotal mass on the left side. He had first noticed the mass inadvertently ten years prior to this admission. The mass had progressively increased in size and was not accompanied with pain. There was no history of venereal disease or trauma to the area. On physical examination the patient's general physical status was excellent. In the left scrotal compartment a palpable mass approximately 4 to 5 cm. in diameter was found which was hard, movable, non-translucent and non-tender. The mass seemed to be attached to the left testicle. The preoperative diagnosis was that of a tumor mass in the left scrotal compartment, probably a spermatocele.

The operative findings revealed the tunica vaginalis to contain an enlarged amount of fluid compatible with a low grade hydrocele. Adjacent to the lower pole of the left testis and contiguous with the tail of the epididymis was a hard, nodular mass approximately the size of a walnut. It was well circumscribed and encapsulated. The mass was dissected from the surrounding cord structures and testis, and was removed without difficulty. The lower pole of the epididymis and a segment of the vas deferens were sacrificed to provide wide excision. Frozen section of the tumor was reported as a leiomyoma. The testicle was left intact and returned to the scrotum. The patient had an uneventful recovery and was discharged six days later.

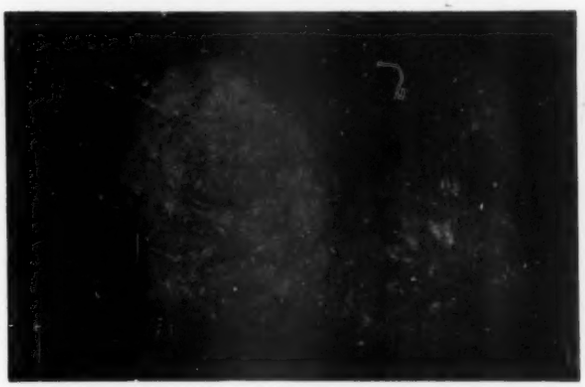

FIG. 1. Leiomyoma of the epididymis; cut surface of gross specimen.

Pathologic examination revealed a mass 4.2 by 3.0 by 2.7 cm. in diameter, weighing 21.5 gm. The firm, oval tumor showed a whitish gray to light brown outer capsule. The cut surface was gray-white, glistening and somewhat bulging, showing whorled trabeculations. (Fig. 1.) Grossly it resembled the leiomyoma of the uterine musculature. Histologic report revealed the tumor to be encapsulated and composed of interlacing bands of smooth muscle tissue with interspersed areas of dense fibrous tissue. (Fig. 2.) The individual cells were spindle-shaped, well differentiated and did not present anaplasia or other characteristics of malignant change. Routine hematoxylin-eosin, Masson's trichrome, Mallory's connective-tissue (Krichesky's modification) and Van

FIG. 2. Microscopic section of the tumor showing interlacing bands of smooth muscles. Low power photomicrograph.

Gieson's connective-tissue stains were done and confirmed the diagnosis of the leiomyoma.

COMMENTS

Leiomyomas of the epididymis are thought to originate from the smooth muscle fibers of this structure. However, Rubaschew [2] in 1926 maintained that leiomyomas should not be considered primary in the epididymis because they take origin from contiguous tissue. He pointed out that tumors of the epididymis may originate from: (1) cells of embryonal tubules, (2) the wolffian or myotome anlage, and (3) adjacent stromal tissues such as blood and lymphatic vessels, fat and fibrous tissue. The usual presenting complaint in benign tumors of the testis, or particularly of the epididymis, is painless, gradual enlargement of a scrotal mass. Occasionally, intermittent pain with radiation to the groin, abdomen and back is present. In many cases there is an associated hydrocele of the tunica vaginalis. The diagnosis of this type of tumor has not been made preoperatively in the reported cases in the literature. Friedman and Grayzel [3] state that "No case of recurrence following removal has been reported nor has there been any instance of malignant change in the tumor."

SUMMARY

A case of leiomyoma of the epididymis has been presented. Tumors of this kind are very rare, and less than twenty cases have been reported to date. It is believed that all masses in the scrotal compartment should be explored if there is any question regarding their nature. Occasionally, rare benign tumors of the scrotal contents are found; however, the grave prognosis of malignant types makes exploration obligatory.

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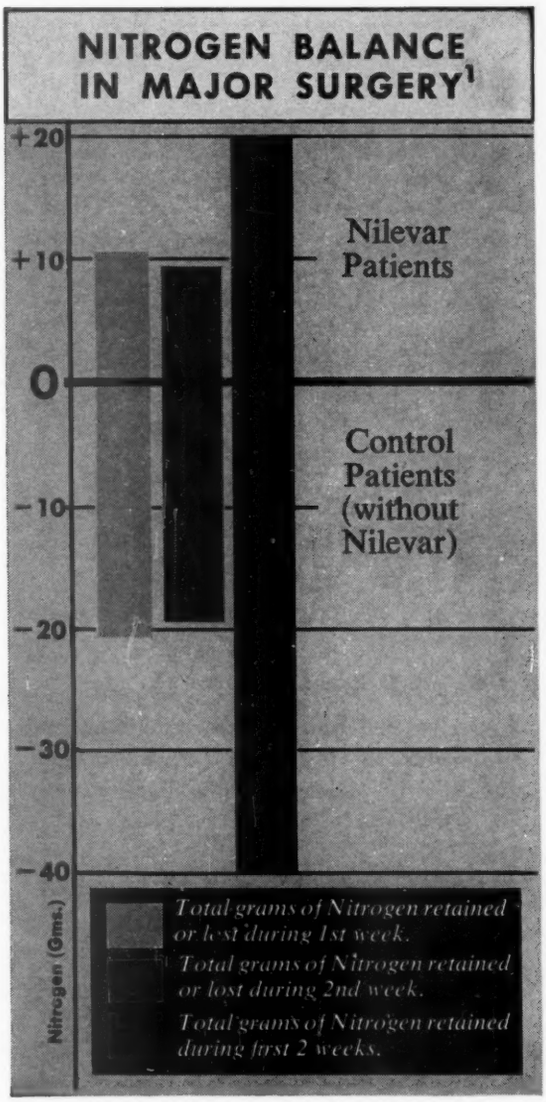

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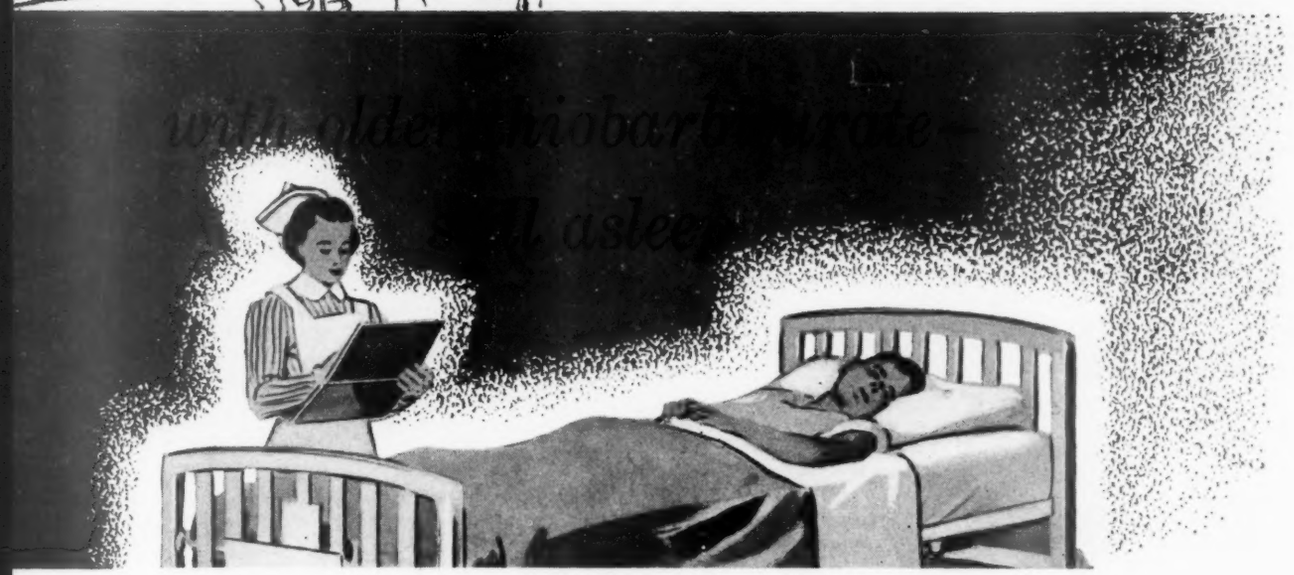

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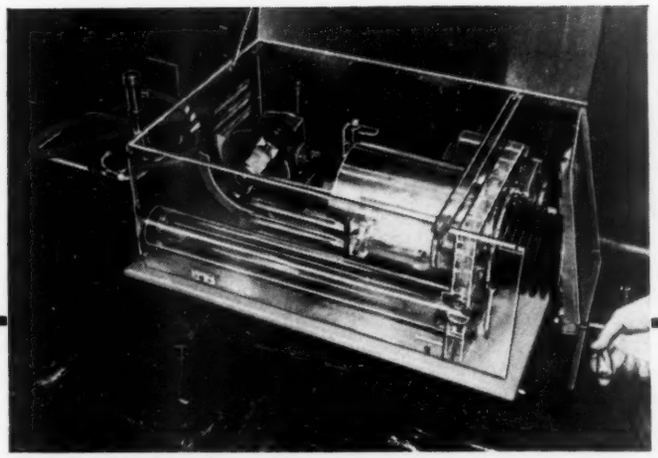

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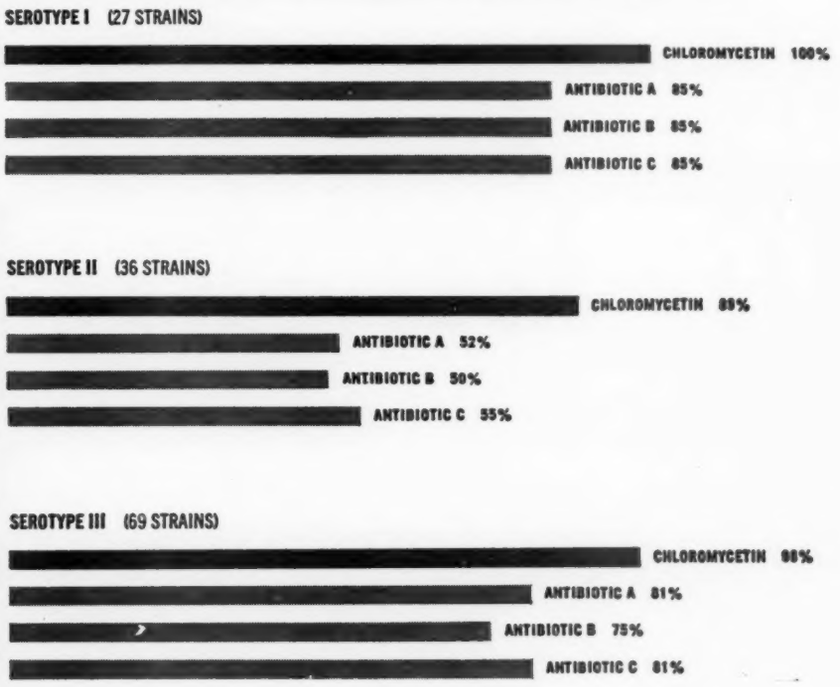

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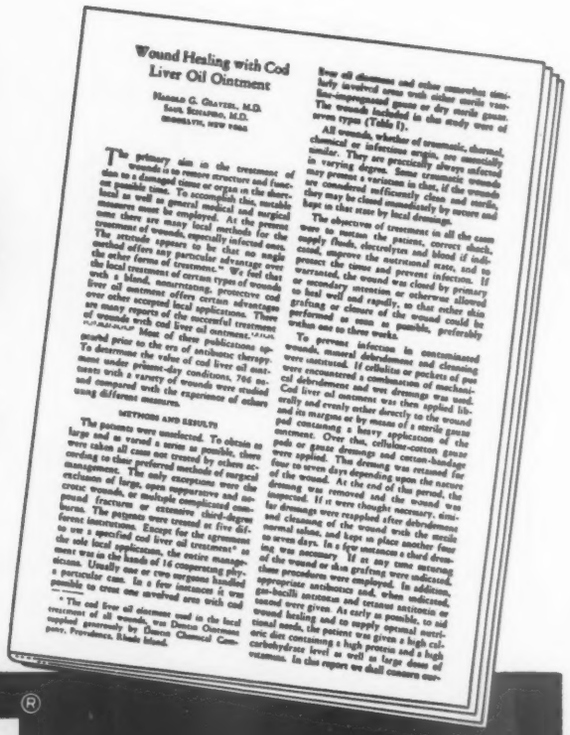

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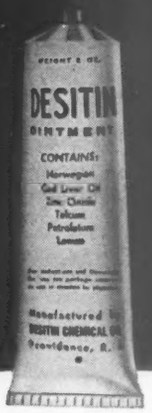

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1. Grayzel, H. G., and Schapiro, S.: Western J. Surgery, Obstet. & Gyn., Oct. 1956.

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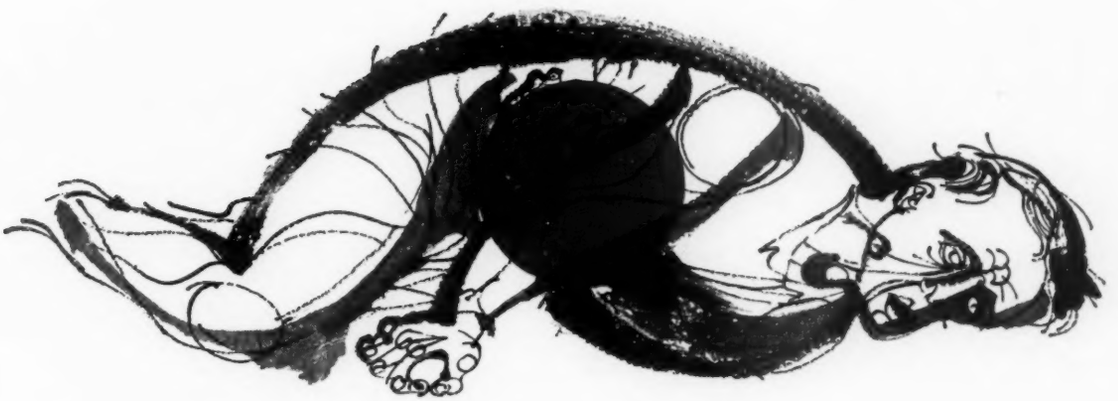

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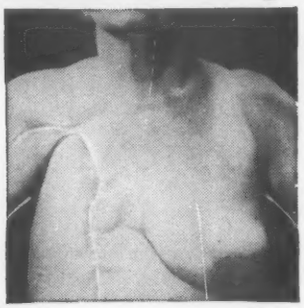

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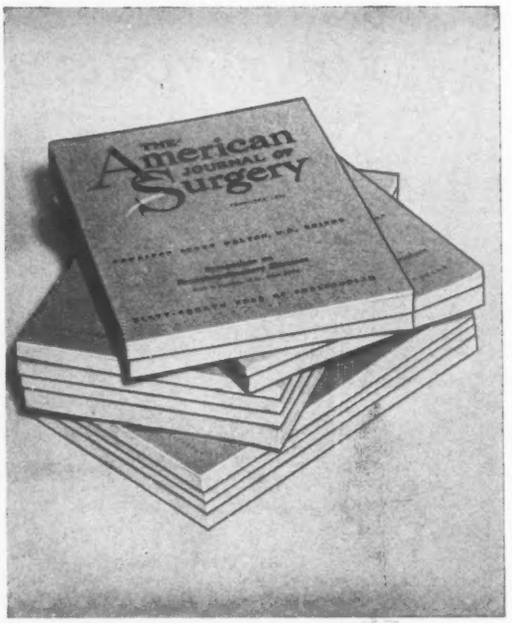

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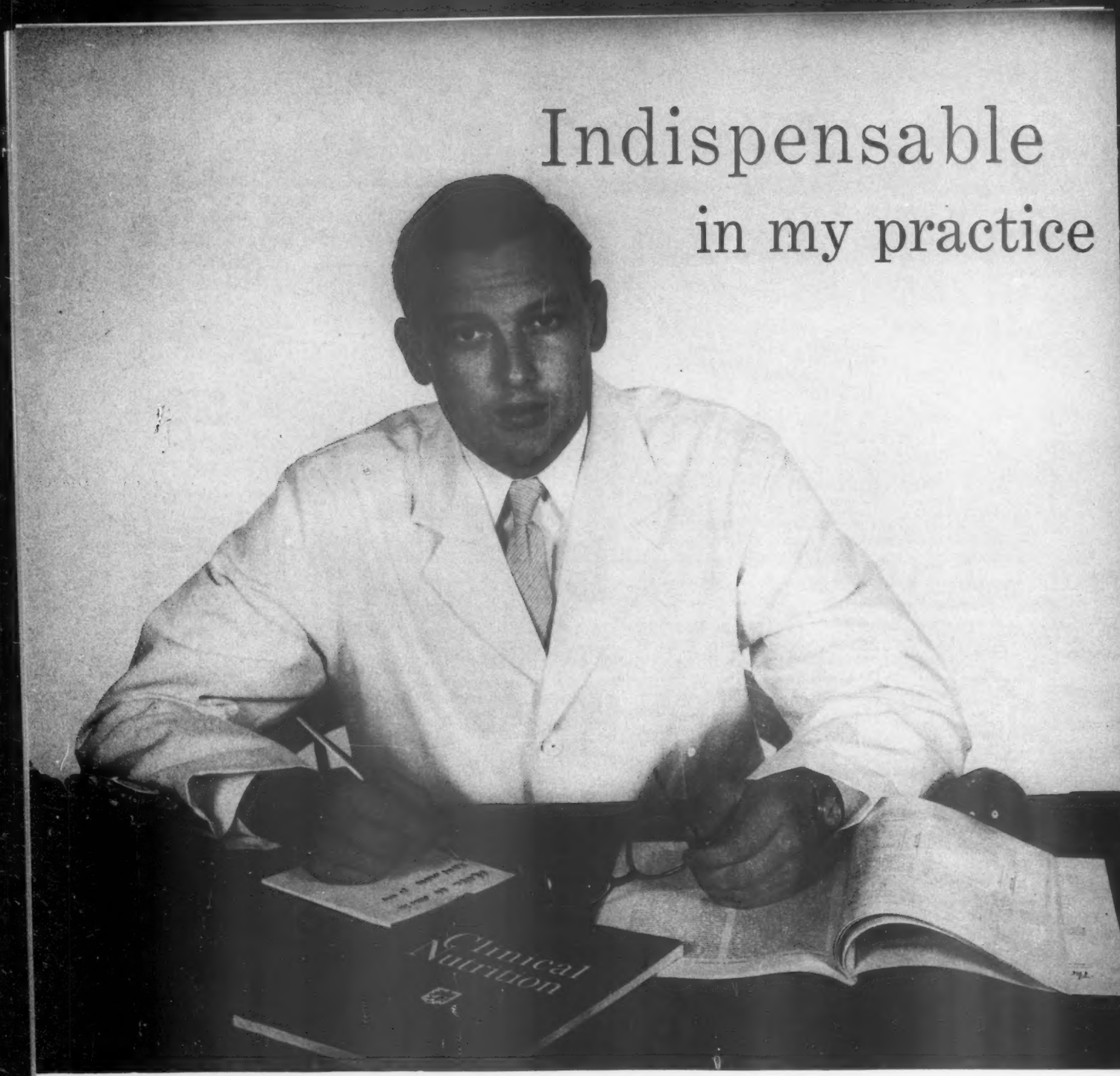

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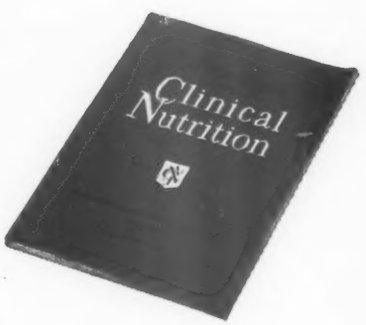

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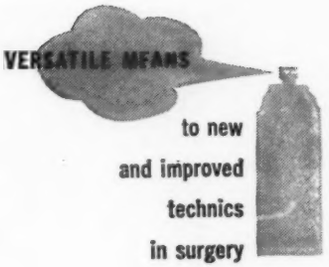

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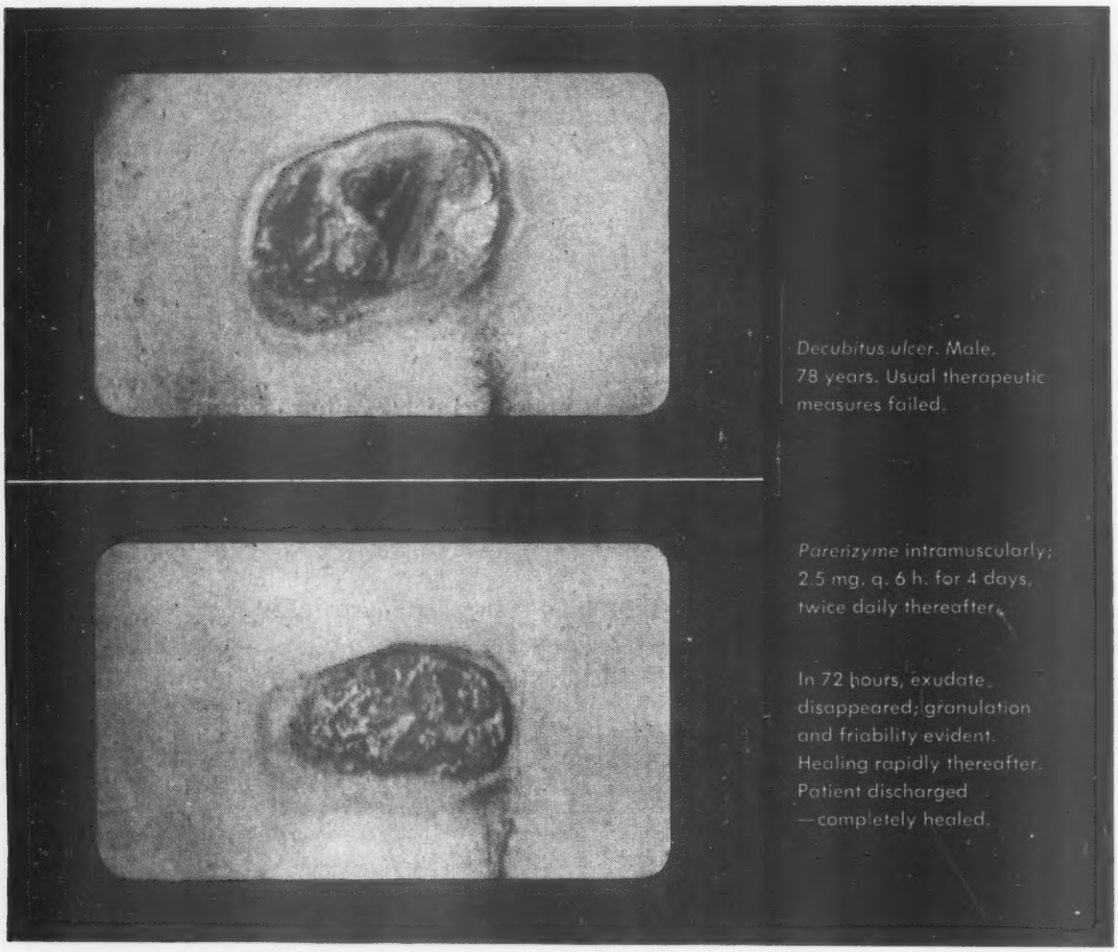

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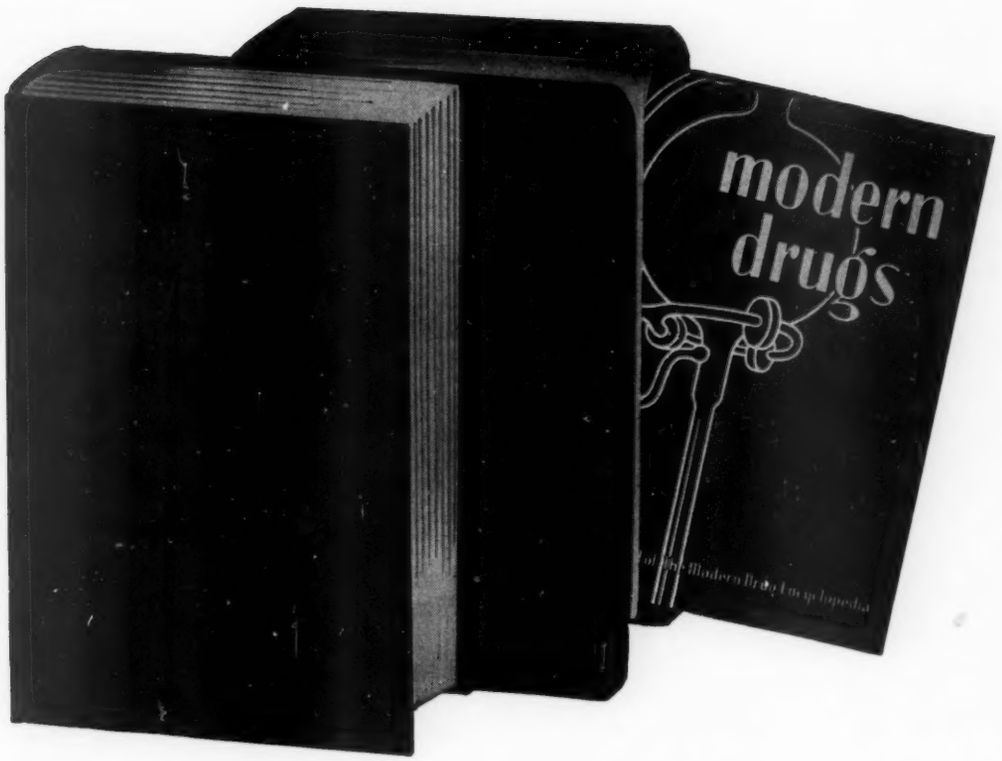

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NOTES AND QUOTES

A RADIOLOGIC health handbook produced for use in training courses at the U. S. Public Health Service's Robert A. Taft Sanitary Engineering Center in Cincinnati is available to the public through the Office of Technical Services, U. S. Department of Commerce.

The 356-page publication contains a glossary of radiologic terms and sections on physical, chemical and mathematical data, radioisotopes, decay, radioassay and radiation protection. A table of isotopes also is included.

The volume, PB 121784 *Radiological Health Handbook*, by S. Kinsman and others, Robert A. Taft Sanitary Engineering Center, Public Health Service, U. S. Department of Health, Education, and Welfare, January, 1957, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C. The price is $3.75.

Some of the reasons why expenditures on medical care today actually represent a great savings of productive time, and even life, were presented recently at the Arizona Pharmaceutical Association annual convention by W. M. Simpson, Jr., Manager of the Western Section, Lederle Laboratories Division, American Cyanamid Company.

Mr. Simpson suggested that pharmacists learn the facts behind the medical care dollar expenditure and then tell this story to their customers.

"When you know all the facts, you can tactfully remind a customer whose illness has been speedily cured by a new drug how fortunate he is to be living now and not a generation ago," Mr. Simpson said.

He pointed out that the best way to do this is to take every opportunity that the pharmacist has to explain the advances in drugs and medical care to customers and neighbors.

"If they (customers) realize that a portion of what they pay for a prescription goes for additional *research to assure better health for their children, or even for themselves, there will be no criticism of your charge," the Lederle executive said.*

He pointed out that the more than $100 million that the pharmaceutical industry now spends annually on research is greater than the total outlay for medical research in Great Britain, and second only to that of the government of the United States.

This research, although costly, has produced the antibiotics that have lowered the death rate in pneumonia from one in three to one in twenty-five, and the cost from five weeks in the hospital at $1,000 to a few days at home with perhaps $30 worth of drugs and a total outlay of only $100.

Research also has produced antituberculosis drugs, antiepileptic agents, insulin, the tranquilizers and steroid hormones, all of which have radically reduced mortality rates and total medical care expenses.

"As opportunities occur," he said, "tell with pride the achievements of your profession and the pharmaceutical industry. In telling our story, people will not only think better of us, but may be encouraged to seek medical treatment oftener and more promptly and with great profit to themselves and the community."

CERTAIN groups of Australian aborigines live without clothes in spite of tropical temperature drops from 90 degrees during the day to some 10 degrees above freezing at night. Their secret of survival is reduced sensitivity.

Professor Peter R. Morrison of the University of Wisconsin's Zoology Department pointed out that the natives "are just less sensitive to sudden temperature shifts than other people."

He reported his findings to fellow scientists attending the annual meeting of the American Federation of Experimental Biologists.

Professor Morrison had an opportunity to observe the natives on a government reservation at Haast's Bluff, a colony west of Alice Springs, while studying Australian wildlife during an academic leave in 1954.

"These people are interesting because they aren't bothered by cold nights—despite the fact that they wear no clothing," he explained.

He pointed out that there are three body adaptations which might ordinarily enable mammals of this type to survive these conditions.

"One is simple natural insulation—skin tissues act as a buffering layer between the cold and the inner body."

The second would be increased production of body heat to counteract an increase in external cold. Neither of these applies to the Australian aborigines, Professor Morrison said.

"These natives simply are not sensitive to

CONTINUED ON PAGE 54

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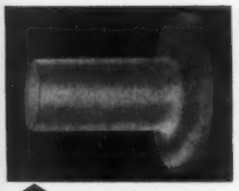

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temperature changes," he explained, "and no apparent changes in body metabolism occur to combat the cold."

He found that the internal body temperature of the natives fell nearly 4 degrees during the night while the average temperature of the skin decreased by only twice that amount.

"The extremities have the greatest decrease in skin temperature," he pointed out. "The mean skin temperature of the feet, for instance, fell some 13 degrees during the night."

Children with eczema can contract a serious and sometimes fatal disease from playmates who have been vaccinated for smallpox, a team of Duke University Medical School pediatricians warns.

Drs. Benjamin A. Johnson and Susan C. Dees outline steps for prevention of the disease, eczema vaccinatum, in a paper which won the Cooper Memorial Award for 1957. The award was presented at the 103rd annual session of the Medical Society of North Carolina.

Eczema vaccinatum, the Duke pediatricians explain, is a generalized spread of cowpox (the disease that produces a sore in an ordinary smallpox vaccination.)

This can happen when a person with eczema or other skin disease comes in close contact with someone who has been vaccinated. Also, a vaccinated person with eczema can contract the disease from his own vaccination.

Terming eczema vaccinatum a "lamentable and preventable disease," Drs. Johnson and Dees offer these rules for its prevention: (1) A person with skin disease should not be vaccinated for smallpox. (2) A person who will be in close contact with anyone suffering from skin disease should not be vaccinated. (3) A vaccinated person should be considered a danger to anyone with skin disease until the scab has fallen from the vaccination site.

IN a 1947 copyright, 25-page brochure on "The Scalp and Its Care" (a physician's manual), the Schering Corporation has offered the medical profession a down-to-earth, sensible scientific monograph on this subject. It is well written and the colored illustrations are above average. If interested, write to: The Schering Corporation, 60 Orange St., Bloomfield, New Jersey.

Deaths from barbiturate poisoning in the United States are on the increase, the Metropolitan Life Insurance Company's statisticians report. In 1955, the latest year for which complete data are available, accidental poisoning by barbiturates claimed 411 lives, as compared with 345 in 1954, 337 in 1953, and 327 in 1952. This reverses the trend for the years immediately preceding.

"Careless use of barbiturates, predominantly by adults, presents a difficult problem," the statisticians observe. "With more stringent restrictions being placed on their sale in many localities, it is not clear why the improvement in mortality which was recorded from 1949 to 1952 has not continued. It would seem that greater efforts should be made to acquaint the public with the dangers inherent in using such drugs carelessly."

About 30 per cent of all deaths from accidental poisoning by solids and liquids during 1955 were caused by barbiturates; this compares with nearly 25 per cent for all other drugs and medicines. The remainder of the fatalities were caused by a variety of substances, including such poisons as wood and denatured alcohol, lead compounds, carbon tetrachloride, benzene, kerosene, the alkalies and insecticides.

Much can be accomplished in reducing the loss of life, the statisticians point out, by keeping drugs and medicines in properly marked containers, by storing insecticides and disinfectants away from food and other edibles, and by keeping poisonous substances out of the reach of young children.

DR. PAUL F. RUSSELL of the Rockefeller Foundation was recently awarded the Darling Foundation Medal and a prize of 1,000 Swiss francs "for outstanding achievements in the control of malaria."

The award was made in Geneva at a plenary session of the World Health Assembly by its President, Dr. Sabih Hassan Al-Wahbi of Iraq, who said that this fifth award of the prize was made to one renowned in the field of antimalaria work, trained for the task by Dr. S. T. Darling who was killed by accident in 1925 during a study mission of the League of Nations Malaria Commission and whose memory the prize perpetuates.

CONTINUED ON PAGE 56

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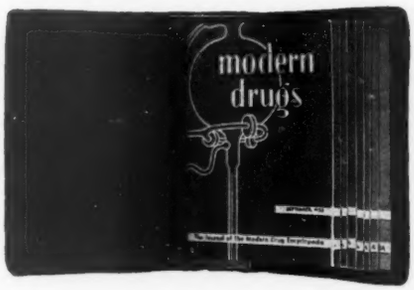

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NOTES AND QUOTES

Discovery of a substance in the human blood stream believed to be the actual cause of high blood pressure and the search for a remedy were announced by the Veterans Administration recently. The chemical substance, called hypertensin, was isolated by a research group at the V. A. hospital in Cleveland, Ohio.

Now the V. A. researchers have started the quest for a chemical agent that will counteract hypertensin and thus check the disease which is man's greatest killer. They are quick to point out, however, that a "cure" is still a thing of the future.

Heading the group, according to Dr. Norman P. Shumway, Director of professional services for research at the Cleveland V. A. hospital, are Dr. Joseph R. Kahn, who has devoted more than twenty-eight years of his life to this project, and Leonard T. Skeggs, Jr., PH.D., a biochemist also known for his work on a new type of "artificial kidney."

Biochemists Dr. Kenneth Lentz and, formerly, Dr. Walton Marsh also have been associated with the project. Their research in a special laboratory in the Cleveland V. A. hospital has been going on for more than ten years.

A MEDICAL milestone was marked recently with the introduction, at St. Luke's Hospital in Chicago, of a new approach to classroom instruction—a "surgeon's eye" technic that brings medical students in unlimited numbers virtually as close to an incision as the doctor's own elbow.

Manufactured by Dage Television, Division Thompson Products, Inc., Michigan City, Indiana, full-color, closed-circuit television is the electronic magic that makes this possible, transmitting to students many floors away the life and death immediacy of the surgical routine. The doctor's commentary, simultaneously transmitted, informs them as well of the special problems attendant upon each individual case.

The drama of the operating room, once available to students only through textbook descriptions or from remote tiers in an amphitheatre, now becomes as intimate as theatre in the round, imbuing viewers with a sense of actual participation.

Achieving this effect is no "production" however; the doctor plays his part unencumbered by the extraneous equipment, producers, directors and technicians that formerly made the televised operation impractical as a regularly scheduled teaching device.

The "surgeon's eye" technic is now available to modern hospitals through new developments in a branch of electronics closely allied with medical science in pushing back the barriers of pain and death.

Use of ultrasonic energy in treating arthritis, bursitis, osteoarthritis and many other related ailments has become a well established practice in physical medicine. Such therapy stimulates circulation of blood and lymph, aids local metabolism, raises tissue temperature, reduces congestion and relieves pain and spasm.

As reported by the manufacturer (American Cystoscope Makers, Inc., 1241 Lafayette Ave., New York 59, New York), the Ultrasonic Therapy Unit, Model UM-600, provides an accurately calibrated sound wave frequency of one million cycles per second, the range considered most suitable for therapeutic use. Dosage intensity up to 3 watts per square centimeter is easily regulated by a single knob. A timer switch automatically shuts off the machine at the end of a designated treatment period.

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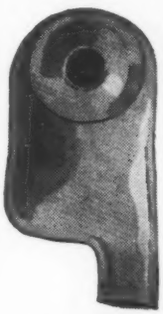
THE Seventh Congress of the Pan-Pacific Surgical Association will be held in Honolulu, Hawaii, November 14–22, 1957. All members of the profession are cordially invited to attend and are urged to make arrangements as soon as possible if they wish to be assured of adequate facilities.

An outstanding scientific program by leading surgeons with sessions in all divisions of surgery and related fields promises to be of interest to all doctors.

Further information and brochures may be obtained by writing to Dr. F. J. Pinkerton, Director General of the Pan-Pacific Surgical Association, Room 230, Young Building, Honolulu, Hawaii.



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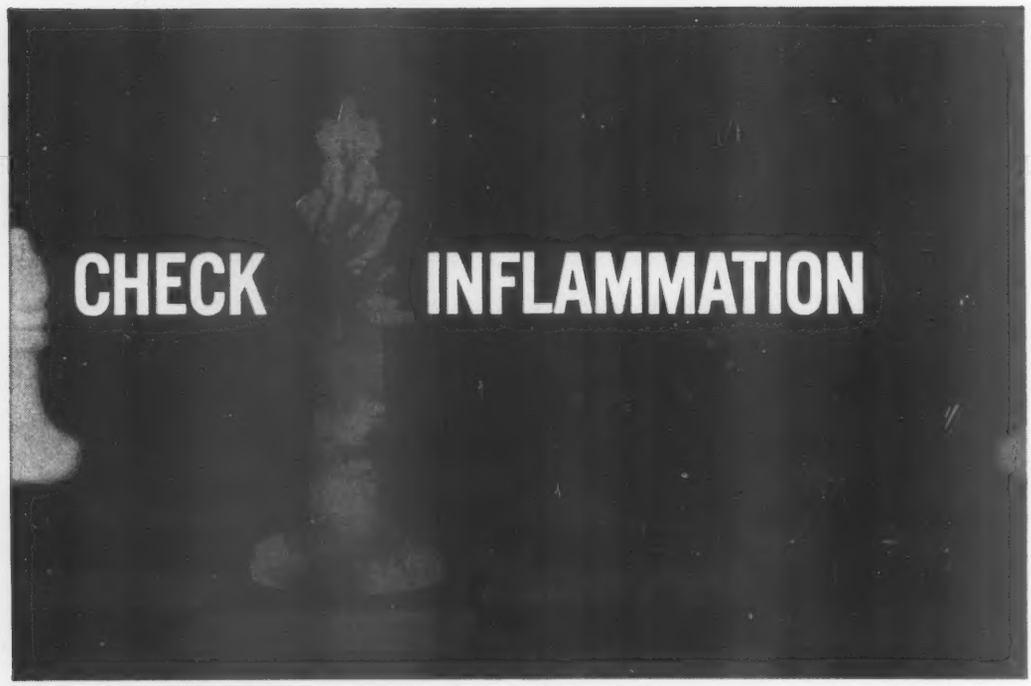

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1. Miller, J. M.; Surmonte, J. A.; Ginsberg, M., and Ablondi, F. B.: Postgraduate Medicine 20:260 (Sept.) 1956.

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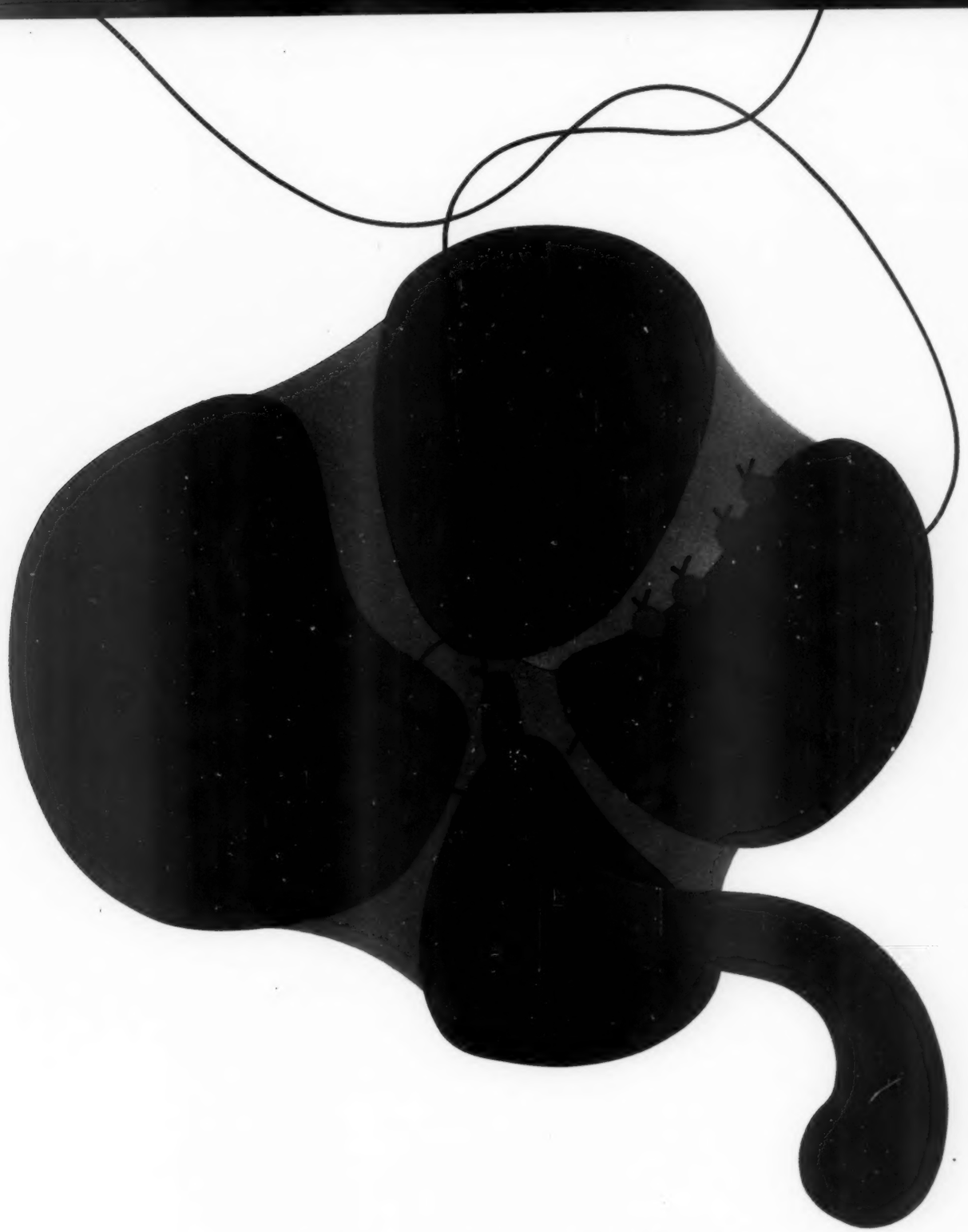

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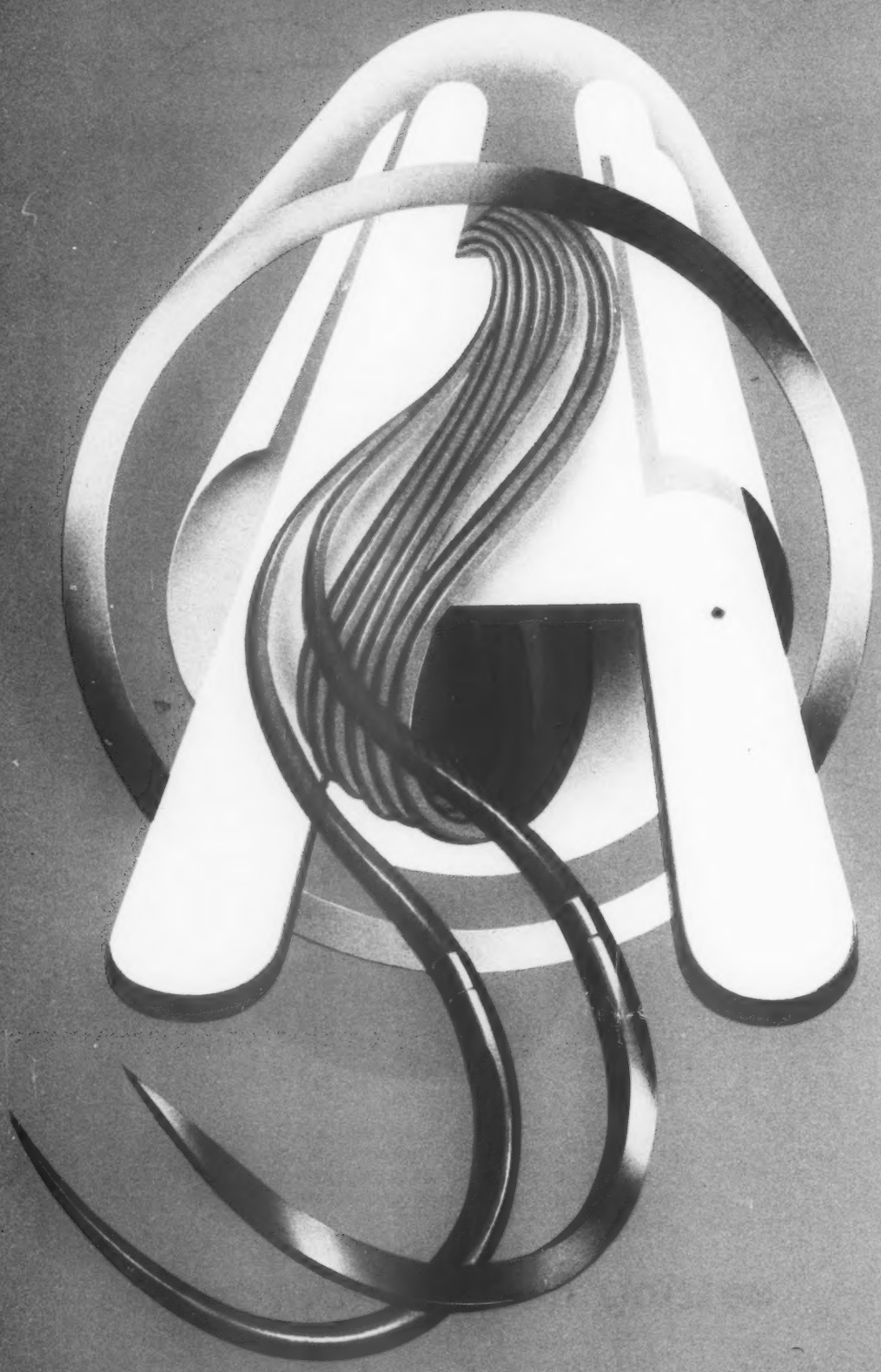

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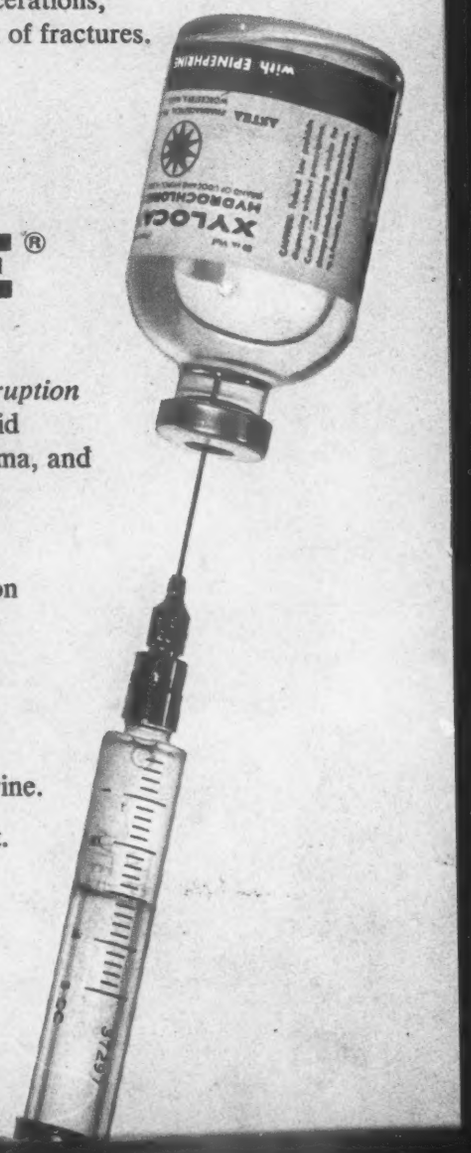

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*Southworth, J. L., and Dabbs, C. H.: Xylocaine: a superior agent for conduction anesthesia, Anesth. & Analg. *32*:159 (May-June) 1953.

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